Chymical Lectures:

2

In which almoſt all the

OPERATIONS

OF

Chymiſtry

ARE

Reduced to their True PRINCIPLES, and the LAWS of NATURE.

Read in the Muſeum *at* Oxford, 1704.

By JOHN FREIND, M. D. Student of *Chriſt-Church*, and Profeſſor of *Chemiſtry*.

To which is added,

An APPENDIX, containing the Account given of this Book in the *Lipſick Acts*; together with the AUTHOR's Remarks thereon.

The SECOND EDITION.

LONDON:

Printed for AARON WARD at the *King*'s *Arms* in *Little Britain*, and THOMAS LONGMAN at the *Ship* in *Pater-Noſter-Row*. 1737.

THE TRANSLATOR TO THE READER.

THE following Treatise, which Mechanically accounts for the several Operations in Chymistry, *being a Theory entirely New, and but lately Communicated to the Learned, I*

thought, by dreſſing the Author's *Diſcourſe in our own Language, I might oblige many, who, tho' not ſo very converſant with the* Latin, *yet are very well acquainted with Mathematical Reaſoning. And I was farther encourag'd hereto, finding the good Reception ſome Pieces in* Engliſh *have met with, which Mechanically explain and account for divers* Phænomena *relating to* Phyſick. *But above all, the* Animal Secretion, *having been ſo well explain'd*

by Dr. James Keil, *from the Principle of* Attraction, *I had good Reaſon to think, that this Theory of our* Author's, *being built in great part upon the very ſame Principle of* Attraction, *would be equally grateful to the* Engliſh *Reader.*

Beſides, the Principle of Attraction, *which ſo happily accounts for the* Phænomena *of* Nature, *being the Diſcovery of Sir* Iſaac Newton, *our Countryman, I concluded it would be but a*

piece of Juſtice, that the Engliſh Reader *ſhou'd ſhare in the Products of ſo Noble an Invention.*

Particular Care has been taken to give the Author's Senſe full and clear, and I doubt not but the Engliſh Reader *will think himſelf oblig'd, for being furniſh'd with ſuch a Reaſonable Account of the ſeveral Operations in* Chymiſtry, *as this Treatiſe affords; a Thing never before attempted with any tolerable Succeſs.*

The

to the Reader.

The Latin *Edition of this Treatiſe has met with very good ſucceſs in the World, and therefore was lately Reprinted in* Holland ; *which Impreſſion has given Occaſion to the* Editors *of the* Lipſick *Acts, to publiſh a ſhort Account of the Work: but before they do it, they ſhew themſelves very much diſſatisfied with the Principle of* Attraction, *without advancing any thing for Proof againſt its Exiſtence. This Account of Theirs, together with the*

Doctor's

The Tranſlator, &c.

Doctor's *Remarks upon their Objections, we have plac'd at the End of the following Treatiſe.*

THE

THE *AUTHOR's* PREFACE.

YOU have here, kind Reader, a Sett of Chymical Lectures, *just as they were Read some Years ago, which I am induc'd to make publick for no other Reason, but that I have too just a Suspicion they wou'd be publish'd by somebody else. Upon a fresh Perusal of 'em, I found them in many places so imperfect and deficient, that they wanted no additional*

additional Miſtakes of a careleſs Tranſcriber, to make them ſtand in need of great Allowances from the Reader. Forc'd therefore they are to the Preſs; tho' I muſt confeſs, I ſubmitted to this Neceſſity with leſs Reluctance, becauſe I ſaw an open way for Mechanical Reaſonings on this Subject already pointed out.

The Principles which I here, for the moſt part, go upon, have been lately Explain'd by Mr. John Keil *, to whom not only my ſelf, but the Learned are much indebted. And upon this account it is, that I now thought it leſs unſeaſonable for me to appear in this Argument; ſince by this way and method of Reaſon-*

* Theoremata de Vi Centri petâ. *Philoſ. Tranſ.*

ing, which I have endeavour'd, as well as I cou'd, to pursue in the Investigating the Laws of Nature, one may see in some measure how much is contain'd in the Thoughts of my Worthy Friend, and to what manifold Uses they may serve. For tho' many may slightly pass over more General Axioms, *as of no Service, because not pointing to any certain Purpose; yet when such* Axioms *come to be more distinctly Consider'd, and apply'd to some particular Subjects, they are then more evidently perceiv'd, and more readily embrac'd. And indeed, if those who employ their Studies in our Art, wou'd rather search out, and rightly apply such Reasonings as are Simple and Uniform, and drawn from*

from Nature her self, than follow the Fictitious Notions of their own Brain, I might venture to say, That the Theory *not only of* Chymistry, *but of* Physick *also, wou'd be less lame and defective. And as often as I turn my Thoughts this way, I can't but be of Opinion, that he alone wou'd be capable of doing Justice to this Subject, who after having exactly view'd and describ'd the* Animal Oeconomy, *should accurately examine the Virtues of* Medicines, *so as to be able to explain to us, both how they are alter'd and form'd in the* Chymical Operations *they undergo, and in what manner they act upon the* Blood. *If these Enquiries were well manag'd, and set in a good Light, methinks I*

see

ſee what an agreeable Connexion there wou'd be between them, how they wou'd mutually illuſtrate one another, and guide us more clearly in our Reaſonings about the Nature of Diſeaſes.

I have ſaid but very little relating to the Principles, *which are commonly mention'd in Books of* Chymiſtry, *becauſe I thought it not worth while to confute Errors. Theſe Treatiſes, I found, contain'd many things not only Trifling, and without any Foundation, but directly contrary to Experience. Therefore I choſe rather to deduce this Mechanical Explication from the Experiments themſelves, than as the way is with moſt Writers in this kind,*

to accommodate Experiments to ſome preconceiv'd Hypotheſis.

For what is ſaid concerning Attraction, *the Force of which is very extenſive in this Enquiry, is not bare Speculation, but taken from the very Nature of Things, and the Propenſion of Bodies, which they are obſerv'd to have one to another, eſpecially that which* Chymical Experiments *diſcover to us.*

As therefore I have advanc'd Reaſonings, hitherto not underſtood by Chymical Writers, *or at leaſt not made uſe of by them, ſo I have ſometimes from Experience given a Deſcription of the Things themſelves, very different from what we find*

find in them. In which Undertaking, if I ſhou'd not pleaſe thoſe who are bigotted to ſome particular Sect, and who take for Principles *uncertain Notions of Things, which no where exiſt; yet I hope ſo far to gain the good Eſteem of ſuch, who will not ſuffer their Judgments to be impos'd upon, as to be look'd on as one who has enter'd upon the true way of promoting this Study.*

I have employ'd all the Care and Diligence I cou'd in making the Tables *and* Experiments. *For 'tis not a thing that can be done without a great deal of Pains and Patience. Therefore I have often willingly had the Aſſiſtance of Dr.* Rich. Frewin, *a Perſon every Way worthy of the*

Place

Place *that bred him, and very well vers'd in all sorts of Learning, especially those which relate to Physick.*

The

The First Lecture.

Of the Principles and Operations of CHYMISTRY.

THE Art of Chymiſtry has indeed been with great Induſtry improv'd and enlarg'd, but has not yet been reduc'd to the Rules of true Philoſophy. However it ſeems to be ſo capable of Illuſtration, as it may ſome time or other be thought to deſerve a place among the Sciences. Thoſe who have hitherto deliver'd down to us the Phænomena of Chymiſtry, have made uſe of ſuch Principles which could be hardly underſtood, much leſs explain'd; ſo that no wonder if having laid no

Foundation, they cou'd raiſe no Superſtructure. They have diſcourſed in ſuch a manner as if they intended only to caſt a Vail before their own Ignorance, or at leaſt not much to enlighten others. So that every thing that has been ſaid of the Nature of Principles, is not only obſcure, but fictitious; neither agreeing with Nature nor their own Syſtems. So difficult it is for a Fiction, that has no Ground-work of Truth to ſupport it, to be conſiſtent with it ſelf to the End. We own Chymiſtry has made a very laudable Progreſs in Experiments; but we may juſtly complain, that little Advances have been made towards the Explication of 'em. The Stock of theſe Materials is very large and ſplendid, but the Rationale of them is ſtill intirely wanting. The Three, or as others will have it, the Five Principles of *Paracelſus*, the

Alkali

Alkali and *Acid* of *Tachenius*, are perhaps not openly acknowledg'd, but are at leaſt too much allow'd of by our modern Chymiſts, who in words may diſapprove of that way of Reaſoning, but mean the ſame thing in other Terms. Nor is there one to be found, among ſo great a Number of theſe Writers, who does not fall into thoſe very Hypotheſes, which he condemns in others; or at leaſt there is not one, who has laid down ſuch Fundamental Principles of Chymiſtry, upon which a juſt and rational Explication may be built. For in reality they have not Examin'd what the true Nature and Mechaniſm of Bodies is, but have only Deſcrib'd it ſuch as they would have it be; inſomuch that they have aſſign'd Laws and Properties to Bodies, that agree neither to the Rules of Mechaniſm, nor yet with themſelves. No Body

has brought more Light into this Art than Mr. *Boyl*, that famous Reſtorer of Experimental Philoſophy: Who nevertheleſs has not ſo much laid a new Foundation of Chymiſtry, as he has thrown down the Old; he has left us plentiful Matter, from whence we may draw out a true Explication of things, but the Explication it ſelf he has but very ſparingly touch'd upon. So that the Way whereby Chymiſtry might be examin'd and illuſtrated by Mechanical, that is, by true Principles, was firſt ſhewn us by Mr. *John Keil*, a Perſon, who has very well deſerv'd of the Philoſophical World, and eſpecially of this Univerſity: Who, when he has publiſh'd the *Second* Part of his Introduction to *Phyſicks*, will thoroughly convince us how eaſily the greateſt Myſteries of Nature may be explain'd, when one of ſound Philoſophy

loſophy and Judgment undertakes that Task.

Making uſe therefore of theſe Principles, I ſhall endeavour to diſcourſe more fully upon thoſe things, which chiefly relate to the Knowledge of Chymiſtry, and ſhall explain, with all the Perſpicuity poſſible, its primary Operations; a Work which ſeems to be the moſt wanting of any.

This Method I make choice of, as well becauſe 'tis moſt Simple and Natural, as becauſe I have known that thoſe *Courſes*, which are commonly gone through, without any regular Order or Diſtinction, are ſo far from doing any good, or leaving the leaſt imperfect Notion of Chymiſtry in the Mind, that the Audience is rather confounded, than inſtructed by them.

The Method therefore we ſhall take, will be, *Firſt*, To explain the

particular Operations, in that Natural Order they are connected one with another; and to ſhew at the ſame time by what Mechanical Force they are principally produced, and to what Uſes they chiefly ſerve. *Secondly*, To declare the various Ways, in which 'tis poſſible and uſual for them to be perform'd. *Thirdly*, To relate the particular Experiments in their proper places, and to reduce them to the general Theory.

But the way to all that is to be ſaid, will appear much eaſier, if we be allow'd to borrow certain *Lemma*'s and *Poſtulatum*'s from Geometry and Natural Philoſophy, which we make no queſtion but the Learned will readily grant us; and thoſe, who don't underſtand them, are deſired to believe them.

1. *All Similar Bodies are in a Triplicate Ratio of their Homologous Sides,*

Sides, and therefore Spheres are in a Triplicate Ratio of their Diameters, or are as the Cubes of their Diameters. Also in Similar Bodies that are of the same Density, their Weights are as the Cubes of their Diameters: But their Superficies are in a Duplicate Ratio of their Diameters, or as the Square of their Diameters.

2. *The Moments of Bodies, or the Quantities of Motion, are in a Ratio compounded of the quantity of Matter, and their Celerity.*

3. *If a Body be specifically heavier than the Fluid, into which it is immers'd, it descends with the Force, which answers to the excess of its Gravity: But if it be lighter than the Fluid, it is carried upwards by the Force, with which its own Gravity is excceded by the Gravity of the Fluid.*

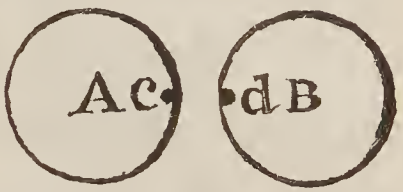
4. *That there is an Attractive Force,*

or that all the Parts of Matter are drawn towards one another.

5. *This Force is diffus'd but a very little way; ſo that when Bodies come to be at ſome diſtance, it almoſt vaniſhes. Nor does it come to be ſenſible, unleſs when the Particles of Matter draw nearer one to the other; But at the point of Contact it is ſtrongeſt. And therefore the Attractive Force decreaſes in a Ratio of the increaſing Diſtances, which is more than Duplicate.*
6. *This Force is different according to the various Texture and Denſity of the Particles: But in Gravity 'tis quite otherwiſe, for that always remains the ſame, however the Texture of Bodies is chang'd.*
7. *But the Attractive Force is greater in one ſide of the ſame Particle, than in another.*
8. *Particles, by how much minuter they are, with ſo much the greater*

Velocity

Velocity they approach each other. For the Attractive Force exerts it self only in those Particles which are very near one another; as for instance, in d *and* c; *The Force of such as are remote is next to nothing. Therefore no greater Force is requir'd to move the Bodies* A *and* B, *than what would put into motion the Particles* d *and* c, *when disengag'd from the rest. But the Velocities of Bodies moving with the same Force are reciprocally, as the Bodies themselves. Therefore the more the Body* A *exceeds the Particle* d *in Magnitude, the less is its Velocity; and this Motion is so languid, that oftentimes 'tis overcome by the Circumambient Medium, and other Bodies. Hence it is that this Attractive Force does scarce exert it self, unless in the smallest Particles, separated from the rest.*



9. *The*

9. *The Force by which Particles cohere among themſelves ariſes from Attraction, and is chang'd many ways, according to the various quantity of Contact.*

Theſe Propoſitions being thus premis'd, which the Mathematicians demonſtrate, let us proceed to explain the Doctrine of Chymiſtry. Now this being an Art, which conjoins the ſaparate Parts of Natural Bodies, and which divides 'em when conjoin'd, and that for the moſt part by the help of Fire, it may be conveniently divided into Two General Claſſes, (*viz.*) DIACRISIS or *Diſſociation*, and SYNCRISIS or *Compoſition*. Tho' this Diviſion be retain'd by many, yet 'tis not agreed amongſt them, what Operations belong to either kind; ſince what ſome place in the Claſs of *Diſſociation*, others refer to *Compoſition*. But we will endeavour to ſhew a new kind of method

method, and uſe Arguments to prove the Reaſonableneſs of it. The chief therefore of the Firſt Claſs are *Calcination*, *Diſtillation*, and *Sublimation*; of the latter are *Fermentation*, *Digeſtion*, *Extraction*, *Precipitation* and *Cryſtallization*. Theſe being the principal Operations, the reſt which are reckon'd up in Chymical Authors are eaſily reduced to them; or at leaſt theſe being well underſtood and explain'd, the Cauſes of the reſt may be clearly conceiv'd.

But before we enter upon the Operations themſelves, it will not be amiſs to ſay ſomething of thoſe Subſtances, which ariſe from the Reſolution of Bodies, by the help of Chymiſtry; to the end that we may underſtand the Terms at leaſt, if not the Things, which the Chymical Authors are ſo full of. By the Force of Fire, Bodies are reduc'd either into *liquid* or *dry* Subſtances.

ſtances. The *liquid*, if ſharp, and not combuſtible, are call'd *Spirits*, which are nothing but *Salts* diſſolv'd in Phlegm; if inſipid, go under the Name of *Phlegm* or Water. Of *dry* Subſtances, thoſe which affect the Taſt, and are diſſolvable in Water, are term'd *Salts*: Thoſe which are Inſipid, have a double Denomination; for either they are *Volatile*, and call'd *Flowers*; or *fixt*, and then are ſtyl'd *Earth*, or *Caput Mortuum*. *Oil* or *Sulphur* with the Chymiſts, denotes not only *Liquid* Oils, but any Combuſtible Matter; tho' they have alſo a Sulphur, which is not Combuſtible.

After this manner the Parts, which Bodies are reſolv'd into by the help of Chymiſtry, are for the moſt part diſtinguiſh'd and defin'd, which are taken accordingly for *Principles* by almoſt all that treat of this Art. But how improperly

properly this Name is apply'd to them, needs not now to be prov'd at large. For you your ſelves will quickly perceive, that they are neither to be found in all Bodies, nor incapable of being chang'd into one another. The bare Difference of Texture, which is the Effect of the Fire, produces all thoſe Subſtances, which are vulgarly cry'd up for Elements; juſt as the ſame Blood, when transfus'd and ſtrain'd through different Organs, conſtitutes Juices which agree neither in Smell nor Taſt, nor ſo much as in Conſiſtence.

It may be thought perhaps I ought to ſay ſomething of *Acid* and *Alkali*, Words which are now in every Body's Mouth. But I cannot ſee what Definition can be adequate to them, as they are pretended to be repugnant and contradictory to one another: I ingenuouſly confeſs,

I am

I am ſo far from comprehending what theſe Terms really ſignify, that I don't thoroughly conceive what the Chymiſts themſelves wou'd mean by them. For if they wou'd have that an *Acid* which pricks and corrodes, and that which does not corrode but prick, an *Alkali*; there are Subſtances which they will allow to be *Alkali*'s, and at the ſame time they cannot deny that they are corroſive. Or if in mixing them with *Syrup of Violets*, they will call that *Acid* which makes a *red Colour*, and that an *Alkali* which cauſes a *Green*; there will be many of both Sorts which produce neither Colour, nay and ſome which occaſion a quite contrary one. The ſame may be ſaid of Experiments, which are made with the *Solution of Vitriol.* Or if they pretend to evince their Nature from their Fermentation and mutual Antipathy,

Antipathy, we are not at all the wiſer in this Matter. For whatever mortal Hatred may ariſe between an *Acid* and an *Alkali*, yet ſometimes both the one and the other have no leſs Contention with ſome of its own kind, *Acids* jarring and fermenting with *Acids*, and *Alkali*'s with *Alkali*'s: And what in reſpect to one Body is nam'd *Alkali*, is, if compar'd with ſome other, by the very ſame Writers call'd an *Acid*. So that in vain we endeavour to fix the Boundaries, which ſeparate each kind. This alone will make us ſufficiently ſenſible, how true an Explication of Nature we are to expect from thoſe, who upon the Doctrine of *Acids* and *Alkali*'s, form Theories not only in Chymiſtry, but in Phyſick too, when they don't ſo much as underſtand the Terms they make uſe of.

The

The Second Lecture.

Of Calcination.

PUrſuant to the Method propos'd, I ſhall begin with *Calcination*, which is ſuch a Separation of Bodies by Fire, as makes 'em eaſily reducible into Powder; and for that reaſon 'tis call'd by ſome *Chymical Pulverization.* This being ſcarce ever perform'd without *Melting* or *Fuſion*, both of 'em may be very properly treated of as the ſame Operation, eſpecially ſince both of them are equally to be accounted for from the ſame Principles.

Bodies therefore are Melted, or put into Fuſion, (for thoſe Words ſignify the ſame thing, tho' diſtinguiſh'd by ſome) when of Solids they

they become *Fluids*. So that if we know the Cauſe of Solidity and Fluidity, we ſhall eaſily underſtand the Nature of Fuſion. The Solidity, or what is here the ſame thing, Hardneſs of any Body, *i. e.* the Force, whereby it reſiſts Separation, ariſes from a mutual *Coheſion* of its Parts. And Coheſion is deduc'd from, and is always proportionable to an *Attraction*, that neceſſarily reſides in all Matter. But the *Attractive Force* being ſtrongeſt at the Point of Contact, is the cauſe, why the Surfaces of the Parts are more firmly united, and yield more ſlowly to any Separation, in proportion to the number of Points they touch one another in: But where the Coheſion of Parts is but ſmall, as in Spherical Bodies, whoſe Superficies touch only in a Point, ſo that their Particles eaſily give way to every little Shock, and are

put into Motion, whether it be by Nature or Art, there *Fluidity* takes place: And how this may be effected by the Force of Fire, is eaſie to conceive. For whilſt the Particles of Fire inſinuate themſelves into the Matter which is to be melted, they ſo break and ſeparate it, that there is a much leſs Contact of Parts, and conſequently a weaker Coheſion. And this Coheſion may be ſo far weakened, by diminiſhing the degree of Contact, as not to keep the Parts from ſliding over one another, or running into a Fluid. Juſt in the ſame manner as Bones are reduc'd into a Fluid Maſs, like Broth, in *Papin*'s Digeſtor.

That the Parts of Bodies may be ſo divided and ſeparated from mutual Contact by Fire, is evident from the *Rarefaction*, which is obſerv'd in their Fuſion: For unleſs the Particles of Fire gain'd admiſſion, ſo as to ſet

'em

'em at a greater distance from one another, and thereby lessen their mutual Contact, there wou'd be no Reason, why they shou'd expand themselves into a larger compass. For we find a Plate of *Iron*, whilst red hot, does not only increase in Bulk, but in Length too. The same thing may be observ'd in *Calcining* of *Copper*. In like manner roasted Flesh swells a little, especially when the Skin is not taken off, as in Pigs. For in all these Instances, the Particles which the Fire has separated, take up a larger Space.

From this difference of *Cohesion* proceeds all that Variety we observe in the Fusion of Bodies: For such as have a less Contact of Parts sooner give way to the Fire, and sometimes melt away by the warmth of a *Vapour* only; but others, which have a stronger Contact, are with difficulty dissolv'd. 'Tis on this account

Vegetables are very eaſily melted, *Minerals* ſlower, and *Metals* ſloweſt of all. And of the laſt, thoſe wherein the Contact of Parts is leſs, as in *Tin* and *Lead*, more readily give way; but thoſe which are more Compact, as *Gold* and *Silver*, are not overcome but with a violent Fire. Now if the Force of Coheſion was proportional to the Quantity of Matter, or to the Weight of Bodies, we might from *Staticks* account for all the Variety which occurs in Fuſion; for by knowing the Specifick Gravity of a Body, we ſhou'd then know what Force it requir'd to melt it. But becauſe the ſame quantity of Matter may be ſo variouſly diſpos'd, that in one Body there ſhall be a much greater Contact than in the other, tho' the Gravity be equal, or even leſs, at the ſame time, therefore the Force of Coheſion cannot be eſtimated by Gravity:

Gravity: Which Experience alſo confirms. For *Lead*, altho' more ponderous than all other Metals, except *Gold*, yet in the Fire is more eaſily melted than any other. So that it neceſſarily follows, that in this Metal there muſt be a leſs Coheſion, or Contact of Parts, how much ſoever it may exceed others in the quantity of its Matter.

Bodies, after Fuſion, return again into a ſolid Maſs, upon their removal from the Fire, and the Ceſſation of the Motion, which the Fire produced; becauſe their Particles are brought nearer one another, by their Attractive Force, and ſo forc'd to unite. Such as conſiſt of Homogeneous and Unalterable Parts, as *Wax*, *Gums*, and the purer *Metals*, recover their ancient Form; for when the ſame Texture of Parts remains in the whole Body, it muſt of courſe reaſſume the ſame Ap-

pearance. But other Bodies, whoſe Parts, with reſpect to Denſity and Surface, are extremely different from one another, while ſome are carry'd off, by the force of the Heat, and others are chang'd, as to Figure or Poſition, muſt be forc'd to appear in another Form: For they can't recover their original Likeneſs, unleſs every Particle cou'd reinſtate it ſelf in that very Situation it had before; which may be hinder'd infinite ways, as may eaſily be experienc'd in *Heterogeneous* Bodies, ſuch as *Vegetables*, and all *Minerals*, as likewiſe the baſeſt ſort of *Metals*. After this manner, every *Plant* is turn'd to *Aſhes*; and *Vitriol*, when all its Moiſture is dry'd away, becomes *Chalcanthum*: And Clay, by the heat of the Furnace, hardens into Tiles and Bricks.

Therefore

Therefore the difference which is obſerv'd, even in *Homogeneous* Bodies, after Liquefaction, is no way to be accounted for, but from the Changeableneſs of *Surface* in its Parts; for thoſe Bodies, whoſe parts conſtantly retain the ſame Surfaces, never loſe their Form; but others, by having the Surfaces of their Parts alter'd, have a different Texture, and put on another Appearance.

Fluidity being in this manner explain'd, *Calcination* may, without difficulty, be underſtood; which, in many Inſtances, is only the effect of a longer Liquefaction. For when the Fuſion is longer continu'd, not only the more ſubtil Particles of the Body it ſelf fly off, but the Particles of the Fire likewiſe do inſinuate themſelves in ſuch multitudes, and are ſo diſpers'd and blended throughout all its whole Subſtance, that the Fluidity, which was firſt caus'd by

the Fire can no longer ſubſiſt. From this Union ariſes a third kind of Body, which being very Porous and Brittle, is eaſily reduc'd to *Powder*: For the Fire having penetrated every where, into the Pores of the Body, the Particles are both hinder'd from mutual Contact, and divided into minute Atoms; ſo that they are eaſily reduc'd to the fineſt Powder. After the ſame manner *Quickſilver* expos'd a long time to the Fire, is at length turn'd to a *Calx*.

Fire ſo divides and rarifies the Parts of Bodies, which are Calcin'd, that upon a ſecond Fuſion they will yield much ſooner than before, as we Experience in the *Calx of Lead*; for the Force of Coheſion, which ſhou'd reſiſt the Fire, is diminiſh'd. So *Copper* and *Silver*, which conſiſt of leſs Volatile Parts, require a very ſtrong Fire to make them Fluid; But when

when they are Calcin'd with *Sublimate*, are melted down even with the Flame of a Lamp. In like manner *Silver*, in the *Luna Cornea*, which is made of the *Chryſtals* of *Silver*, Calcin'd with *Spirit* of *Salt*, diſſolves like Wax at the Fire.

This Separation, and Rarefaction of Bodies, is ſufficiently prov'd by the *increaſe of Weight*, which is, during Calcination, owing to the Fire. So *Lead*, and all other *Metals*, gain in their Weight by Calcination; for if an *Ounce* of *Lead* be reduc'd to a Calx, by the *Flame* of *Spirit* of *Wine*, it will increaſe above a Scruple in weight.

From theſe Experiments, 'tis manifeſt, that not only the Parts of the Body Calcin'd are much broken and rarify'd, but that the very Increaſe of the Weight it ſelf proceeds from the Fire. For the Gravity of Crude *Lead*, if compar'd to *Water*,

is

is as 11½ to 1; but that of *calcin'd Lead* is as 9 to 1. So the proportion of *calcin'd Copper* to *Water*, is but 5$\frac{5}{11}$; but that of Crude is 8½. The Proportion of *White Lead* to *Lead* it ſelf comes out ſtill leſs, *i. e.* Subtriple. Four Ounces of *Regulus* of *Antimony*, if put in Fuſion for an hour and a half, will gain two Drams and a half; tho' in the mean time a multitude of Effluvia go off in Vapours. *Lemery* obſerves ſomething like this in diſtilling Spirit of *Saturn*. Hence the Abſolute Gravity is increas'd indeed by Calcination, but the Specifick is leſſen'd; the Reaſon of which is this, That the Particles of the Body, divided by the Fire, and ſeparated from mutual Contact, are diffus'd into a larger Bulk. But the Particles of Fire, which are much lighter than the Calcin'd Body, being every where mix'd with it, and diſpers'd through

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its Pores, leſſen the Specifick Gravity, and increaſe the Abſolute.

But however the Particles of Bodies are divided and ſeparated by Calcination, ſo as to be depriv'd of their ancient Appearance, yet many *Metals*, and ſome *Minerals*, whoſe Parts are moſtly Homogeneous, don't ſeem to loſe their Nature with their Form. For *Gold*, *Silver*, and *Quickſilver*, cannot be ſo deſtroy'd, by all the *Calcining* imaginable, but that they may with very little trouble be reviv'd. So out of *Salt* of *Tin*, the *Tin* it ſelf may be extracted again; Nay, the *Calx* of *Lead*, the moſt impure of all Metals, returns with eaſe into its original Form. Thus too, not only the *Regulus*, but the very Subſtance of *Antimony*, may be drawn both from the *Calx* and *Glaſs* of *Antimony*. So that Calcination is but *imperfectly* perform'd in ſuch Bodies,

Bodies; for a great many Particles ſeem to be ſo little chang'd and deſtroy'd, that as ſoon as ever they are let looſe from this Artificial Combination, they reaſſume their Proper and Natural Figure. Neither ſhou'd we omit taking notice of what is of the greateſt moment in all Calcination, that thoſe very Particles, whoſe Attractive Force is ſtrongeſt, and which contribute moſt to the Coheſion of Bodies, when Calcining, fly off, and evaporate during Calcination: So that if a great Quantity of ſuch Particles ſhou'd evaporate, another Body of a very different Form may ſucceed. For in melting *Lead*, we ſee the Fumes riſe in ſuch a prodigious Cloud, that at length they leave behind nothing but a *Calx*, which has no manner of Reſemblance with that Metal. On the other hand, if *Gold* and *Silver* be calcin'd after

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the common method, yet they ſtill retain their ancient Form, becauſe ſcarce any of the Particles paſs off in Vapour. And indeed the Corpuſcles, that exhale in a Calcining Fire, are ſuch as have the largeſt Surface, and leaſt Gravity. Therefore *Quickſilver*, whoſe Particles we know are form'd in a quite contrary manner, is with the greateſt difficulty reduc'd into a Calx.

But nothing can more confirm the Account we have given of *Calcination*, than the Arguments which are drawn from the Operation it ſelf. For, in order to its ſucceeding well, we many times *ſtir* the Body that is to be calcin'd with a *Spatula*, or elſe mix it with ſomething elſe. The Deſign of both theſe Methods is to make the Particles cohere leſs together, and to yield more eaſily to the Fire. 'Tis evident, from what has been ſaid of

Copper

Copper and *Silver*, how much ſooner they melt by the heat of the Fire, when *Sublimate* is added to 'em. The Reaſon of this *Phænomenon* may be deduc'd from the Nature of *Quickſilver*, out of which *Sublimate* is made. It is manifeſt from Experiments, that *Quickſilver* will readily unite with almoſt any Body; which plainly proves, that it has a very ſtrong Attractive Force. Therefore theſe Particles, when mix'd with *Copper* or *Silver*, inaſmuch as they exceed in an Attractive Force, cauſe the Particles of either Metal to attract one another leſs; and by that means the Force of Coheſion, which was before in the *Copper* or *Silver*, is abated, and grows weaker. For the greater the Ennergy of Attraction in the *Quickſilver* is, the more is that of the Metalline Particles diminiſh'd. Hence when upon the Addition of

Quick-

Quickſilver, the force of Coheſion in theſe Metals is leſſen'd, they will be the more eaſily brought to Fuſion. What has been ſaid of *Mercury*, holds good in *Salts*. For *Sulphur*, becauſe it abounds with Saline and very Attractive Particles, performs the ſame thing in the Calcining of *Copper*, and in the Making of *Crocus Martis*; for by the admiſſion of theſe Sulphureous Particles, the *Fire* is not only augmented, but the very Texture of the *Iron* it ſelf is divided and open'd, in the manner we have ſhewn, and melts down in Drops. This Calcination of *Iron*, the Chymiſts have given a peculiar Name to, and call'd it *Granulation*. For theſe two Metals have this ſingular Property, that unleſs mix'd with *Sulphur*, or ſome ſuch thing, they can't eaſily be put into *Fuſion*. 'Tis for the ſame Reaſon *Iron* is

Calcin'd

Calcin'd with *Sal Armoniac*, in order to Extract *Mynſicht*'s *Tincture*: So the *Glaſs of Antimony*, and *Crocus Metallorum*, are calcin'd in a much ſhorter time, if you add either Common or Bay *Salt*. Likewiſe *Gold* and *Silver* cannot be reduc'd into a *Calx*, if the Texture of the Metal be not open'd by ſome *Saline Spirit*, or *Mercury*; for which Reaſon the *Refiners* uſe *Borax*, and other Salts, for the quicker melting of the Oar. Laſtly, The Uſe which Calcination ſerves for, agrees exactly with what we have advanc'd: for Bodies are firſt Calcin'd, that they may be the better fitted for other Operations. Therefore we calcine *Vitriol*, that the *Oil* and *Spirit* may be the eaſier Diſtill'd from it: And we melt *Tartar* and *Iron*, that we may extract their Tinctures by *Digeſtion*. For by Calcination the Particles of Bodies

dies are made to cohere much more looſely with one another; and upon that account, become more convenient for any manner of Uſe.

To *Calcination*, belongs *Vitrification*; which Word is properly apply'd to thoſe Bodies, that are Pellucid, like *Glaſs*, after the Calcination is over; to perform which, a longer and more vehement Fire is requir'd. Therefore in the making of *Glaſs of Antimony*, a previous *Calcination* is neceſſary. From hence proceeds the Homogeneous Texture, which is as Eſſential a Qualification in Pellucid Bodies, as a Rectilinear Poſition of Pores. For by the application of *Fire*, the Heterogeneous and more Volatile Corpuſcles are diſſipated, which, by the infinite Number of Refractions they make, very much weaken, and almoſt extinguiſh the Rays of Light: Thoſe, in the mean while, which partake

of the ſame Nature, *i. e.* thoſe which are *denſe* and *fix'd*, being left behind, unite cloſely together; ſo that there being a like Conformation of Parts, on every ſide, which way ſoever you expoſe it, this calcin'd Matter equally attracts and tranſmits the Rays of Light. Thus by a long Fuſion, which throws off the lighter and more droſſy Particles, *Common Glaſs* is made *. This account of *Vitrification*, as it confirms our Method of Reaſoning, ſo 'tis alſo evinc'd by Staticks. For, upon Examination, you'll find, that *Common Glaſs* much exceeds in Gravity that Mixture, out of which it is made. Likewiſe Experiments, which are made to ſhew the Spe-

* *Soda*, which is call'd *Cali*, runs very freely into a Glaſſy Subſtance, by bare *Incineration*; for that Plant abounds with a quick and pungent Salt, ſo that I could extract a great quantity of a very ſharp, and almoſt cauſtick Juice without Fire, from the *Spaniſh Soda*, eſpecially that which grows near *Alicant*.

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cifick Gravity of Bodies, plainly prove, that *Glaſs of Antimony* is heavier than *Antimony* it ſelf; becauſe the lighter Particles evaporate during Calcination. *Tab.* 2.

Decripitation, and *Detonation*, are by the Chymiſts commonly plac'd under *Calcination*; the one is almoſt peculiar to *Common Salt*, the other to *Nitre*, when they are mix'd with Sulphureous Minerals. But they multiply Words to no purpoſe, ſince there is no manner of difference in the Operation. For however *Salt crackles*, and *Nitre bounces*, during the Operation, (by reaſon of the *Rarefaction* and *Impetus* of the inclos'd Air) ſtill each of 'em is calcin'd after the ſame manner. There is alſo another Sort, which is made by *Menſtruums*; but becauſe this is more properly call'd *Corroſion*, we ſhall refer it to its proper place.

The Third Lecture.

Of Diſtillation.

Diſtillation, or as others perhaps not improperly call it, *Humid Sublimation*, is the Aſcent and Elevation of Particles, which afterwards deſcend again in the form of Drops.

This Aſcent of Fluids is chiefly promoted two ways; *firſt*, upon account of their Specifick Levity; and *ſecondly*, by Impulſe.

The firſt way of Elevation is manifeſt from this Lemma, (*viz.*) *That Particles of Bodies, which ſwim in any Fluid, if they are ſpecifically lighter, muſt be born upwards by that Fluid.* Therefore ſince *Diſtill'd* Liquors are carry'd upwards through the Air, we are to enquire how they can

can be made ſpecifically lighter than the Air. Now a Fluid may be ſpecifically lighter than another, when under a larger Bulk, it has an equal, or a leſs Gravity. According to this Proportion the Bulk of the Fluid ought to be increas'd in *Diſtillation*: And how eaſily, by the help of Fire, it may be increas'd, or, which is the ſame thing, *rarefy'd*, one who is but tollerably vers'd in Phyſicks may comprehend. And whoever has but obſerv'd a *Thermometer*, a *Cupping Glaſs*, or *Boiling Water*, muſt be ſenſible, how great a quantity of Air, or poſſibly, of ſome more ſubtil Matter, there is contain'd in almoſt all Fluids, and what a Force there is in Heat to rarefie it: At leaſt, thoſe prodigious Fumes, which riſe in the *Receiver*, upon *Diſtilling Vitriol*, do ſufficiently prove it. For *Rarefaction* is nothing but the ſame quantity of

Matter diffus'd into a greater Space; ſo that the ſame Weight remains, tho' the Bulk grows much larger. From whence 'tis plain, there muſt be a greater Number of Pores in the rarefy'd Body, which are either intirely void of all Matter, or at leaſt of ſuch Matter, as hath any conſiderable Gravity. A very clear Inſtance of this we have in the *Air* it ſelf, which we know, by Experiments of the *Air Pump*, has been rarefy'd to almoſt an infinite degree. Having gone thus far, in explaining this matter; we are now only to find out, what Proportion of Rarefaction is ſufficient to produce this Specifick Levity. And, that the matter may be ſet in a clearer Light, let us begin with the ſimpleſt Bodies, and take our firſt Inſtance from *Water*. 'Tis known by Computation, that the Proportion of the Specifick Gravity of *Water*,

to

to that of *Air*, is ſomething more than 800 to 1. Since therefore *Similar Spheres, or Solids, are as the Cubes of their Diameters*, and the Specifick Gravity decreaſes reciprocally, in the very ſame Proportion as the Cubes of their Diameters increaſe, in order to make a Particle of *Water* lighter than a Particle of *Air*, no more is neceſſary, than to rarefy it 'till its Diameter become *Ten times* greater, which in this caſe is but a very ſmall degree of *Rarefaction*. For the Cube of the Diameter, in a Particle ſo rarefy'd, is 1000. If the Diameter be made *Eleven times* greater, the Cube will be 1331; and if *Twelve*, 1728. So that *Water*, when rarefy'd but *Twelve Degrees*, will be above *doubly* lighter than *Air*. And if the *Rarefaction* be carry'd on farther, we can eaſily collect, from the increaſe of the Numbers, that a Particle of *Water*

may be made almoſt infinitely lighter than *Air*. And that we may bring this a little nearer to our preſent Purpoſe, 'tis manifeſt, that the Elevation of Bodies, equally fluid and heavy, is always proportionable to their different Aptitude to be rarefy'd; that is, they aſcend quicker upon the Application of any Force, the more Suſceptible they are of *Rarefaction*; but in Bodies, whoſe Aptitude to be rarefy'd is equal, the time of Aſcent is to be determin'd by their *Specifick Gravity*: So that the time of Elevation, in Bodies diſtill'd after this manner, is in a Compound Proportion of their *Rarefaction* and *Specifick Gravity*. This exactly agrees not only to Theory, but to Experience, without which Theory alone is not to be regarded. For by the ſame Degree of Heat, *Spirit of Wine*, *Spirit of Sal Armoniac*, prepar'd with *Quick Lime*,

Diſtill'd

Diſtill'd Waters; the Gravity of all which is leſs, and their Rarefaction more eaſie, than of common *Water*, are drawn off proportionably ſooner by the *Retort*. On the other hand, *Acid Spirits*, ſuch as the Spirits of *Salt*, of *Nitre*, and of *Vitriol*, tho' they begin at firſt to riſe more readily, yet require longer time to carry 'em off into the *Receiver*, than *Water* it ſelf does. For tho' the *Rarefaction* of Water be leſs, yet 'tis not ſufficient to anſwer to the *Gravity* of thoſe Fluids. After the ſame manner the Particles of *Vegetables* and *Animals*, whoſe Texture is rarer, and conſequently makes 'em ſpecifically lighter, more eaſily aſcend, than the Particles of *Minerals* or *Metals*. We may here alſo obſerve, that a Body, when *diſtill'd*, is always thinner and more ſubtil, than the *Crude* one, from which it was *diſtill'd*. So

Roſe

Roſe Water has a leſs Conſiſtence, than the *Juice of Roſes*, and is leſs ponderous; and thus *Rectify'd Spirits* have a leſs *Specifick Gravity*, than thoſe which have but once paſs'd the Fire *.

* *Tab.* 3.

But the Caſe is otherwiſe, when we uſe *Abſtraction* in Diſtilling: For Inſtance, *Diſtill'd Vinegar* is heavier than *Crude*; for in this Operation we leave a Liquor behind ſaturated with *Saline* Particles, whilſt all the *Phlegmatick* Part, whoſe Gravity is leſs, is carry'd off. The ſame thing we conſtantly obſerve in what they call the *Dephlegmation* of *Acid Spirits*.

II. Not only *Specifick Levity* ſerves to elevate Bodies in Diſtillation, but an *External Impulſe* alſo may cauſe their Aſcent. The Impulſe, which we have to do with in this place, comes from the Fire; whoſe Particles, tho' they are extremely ſmall and

and light, yet 'tis demonſtrable by *Mechanicks*, that they may raiſe Bodies much heavier than themſelves, by acting upon them with a certain degree of Force. For ſince the *Moment of a Body, or that Force by which it acts upon another, is in a Compound Ratio of the Quantity of Matter, and the Celerity*; the Celerity may be ſo increas'd, as to give a ſufficient Force to the Body, tho' the *Quantity of Matter* in it be never ſo ſmall. Let us therefore ſuppoſe ſome heavy Body to deſcend with no other Moment, than what it receives from its own Gravity; in this caſe then the Air, which is much lighter, may be mov'd with that Celerity, as not only to ſuſtain that Body, but to mount it up higher. And the more rapid the *Impetus* of the Air is, or the *Surface* of the Body more diffus'd, the higher and ſwifter will the

the Elevation be: Juſt as we ſee Sheets of Lead are ſometimes torn away entire by the Wind, and carry'd aloft through the Air. In like manner Fire, tho' it be a Body made up of very minute Particles, may be mov'd with that Rapidity, as to acquire and communicate what Force you pleaſe towards removing any Obſtacles. And this we daily Experience in innumerable Inſtances, but in none more than in *Gunpowder*. When therefore the Moment of Fire is augmented, in the Manner we have Explain'd, ſo as to exceed the force of the diſtill'd Body, it will remove it from its former Situation; or what is here the ſame thing, becauſe the Direction of its Motion tends upwards, will carry it up. Thus Particles, ſpecifically heavier than the Air, which is contain'd in the Retort, as we know thoſe of *Acid Spirits* are, aſcend by

a more

a more violent Impulſe of the Fire us'd in *Diſtillation.*

Another thing, which contributes very much to this Purpoſe, is, that the ſame Quantity of Matter is elevated ſo much the eaſier, in proportion as the *Surface* is enlarg'd; for the more there is diffus'd, the more Particles of Fire it receives; and ſo, having this united Force to drive it up, it more eaſily aſcends. So that by the ſame Degree of Fire Bodies will not equally riſe, tho' they be equally heavy, if there be that difference in their *Surfaces* we have been ſpeaking of. The *Air* alſo has no ſmall ſhare in this buſineſs of *Impulſe*; for being *rarefy'd* by the Fire, it is not only impell'd upwards it ſelf, but carries other Particles up with it. And we may learn by a very familiar Experiment, what *Impetus* Bodies ſo rarefy'd exert. Water, for

Inſtance,

Inſtance, over a Fire cannot be heated but to a certain Degree; for when it has once well boil'd, it can never be made hotter; yet the ſame Water, if it be ſhut up in *Papin*'s *Digeſtor*, will grow exceſſively hot. And if a piece of red-hot Metal be flung into cold Water, it will occaſion much the ſame Exploſion, as we obſerve in *Gun-powder*. But nothing does ſo plainly ſhow the Force of rarefy'd Air, as the Engine by which Mr. *Savery* has taught us to draw up Coals out of the Pits. Whoever conſiders well theſe Three things, and what may be effected by them, *viz. Specifick Levity*, an *Impelling Force*, and the *Extent* of the *Surfaces*, and how many Ways, and in what Proportions all of them may be chang'd, will very eaſily account for all the Variety, which is found in this Proceſs of *Diſtillation*.

It

It muſt be obſerv'd, that wherever *Specifick Levity*, or *Rarefaction*, has any place in *Diſtillation*, there *Impulſe* concurs too; for the Fire equally does both at the ſame time: So that a leſs degree of *Rarefaction* is ſufficient to elevate Bodies, than what we before aſſign'd. But in thoſe Bodies, which are rais'd by *Impulſe*, 'tis not neceſſary that *Rarefaction* ſhou'd concur; for ſometimes there is no *Rarefaction* at all. There is alſo another difference between *Rarefaction* and *Impulſe*, that very much favours our account of *Diſtillation*, that a more gentle Fire may ſerve for Diſtilling ſuch Bodies as are elevated by means of their *Rarefaction*: But thoſe, which are rais'd by *Impulſe* only, require a very intenſe Heat.

As to what concerns the different Method of performing this Operation, there are generally two ways we

we uſe in *Diſtillation.* For 'tis either *Right*, or *Oblique*; the latter is done by the *Retort*, and the former by the *Alembick.* There is but little difference in the Manner of both theſe, excepting only that the *Right Diſtillation* has this peculiar Property, that whatever is Diſtill'd by it, is form'd after the Reſemblance of *Rain.* For as the Watry Vapours, drawn by the Sun's Heat from the Earth and the Sea, and ſo rarefy'd, as to become ſpecifically lighter than Air, aſcend, and are condens'd into Clouds; but afterwards, growing heavier than the Air, deſcend by their own Weight, and ſo diſtil down by Drops in the form of Rain. So the very ſame Reaſoning holds in the *Alembick.* The Fluid Particles of the Body in Diſtillation are, by the Force of the Fire, as has been explain'd before, preſs'd out and elevated upon the account

account of the *Rarefaction* and *Impulse* they undergo, to the top of the *Alembick*, in the form of Vapours; where being resisted and repell'd, and condens'd by the external Cold, they so unite with one another, that by the Force of their *Specifick Gravity*, they descend along the Internal sides of the *Alembick*, from whence they are convey'd into the Neck, as it were through a Canal. The same Explication is to be apply'd to *Oil of Sulphur*, made by the *Bell*. In distilling *Oils*, and sometimes *Spirits*, they apply to the Neck of the *Alembick*, a long *Pipe*, turning and winding like a Serpent, which, by passing through a Vessel of Cold Water, keeps the Vapours from flying off, and condenses them sooner into Drops.

There is another sort of *Distillation* mention'd by Authors, which is by *Descent*; where, when the Par-

ticles of the Bodies are ſeparated by the Force of the Fire in the upper Veſſel, ſuch of 'em, which are more fluid, diſtil into the lower Veſſel: Familiar Inſtances of which we have in *extracting Pitch*, and making *Roſe Water*. But becauſe 'tis almoſt baniſh'd from the *Chymiſts* Elaboratory, we ſhall not conſider it in this place.

But the Reaſon why ſometimes the *Right*, and ſometimes the *Oblique Diſtillation* is moſt convenient, muſt be deduc'd from the Nature and Texture of the Body, which is to be diſtill'd. *Right Diſtillation* is us'd when the *Texture* of the Body is ſuch, as allows of an eaſie Aſcent: Of this laſt kind are *Vegetables*. Other Subſtances, which conſiſt of heavier Particles, give way but ſlowly to the Fire, and cannot be rais'd to the Top of the *Alembick*; ſuch are almoſt all *Minerals* and *Metals*; and

theſe

theſe therefore are only capable of *Oblique Diſtillation.*

The *Right*, being the more gentle Operation, belongs to thoſe Bodies only, which are eaſily rarefy'd; but the *Oblique* is deſign'd for the moſt part for ſuch as can't be elevated without a ſtrong Impulſe; which accordingly is the only *Diſtillation*, we make in the *Reverberatory.*

We may obſerve in *Diſtillation*, what ſeldom or never happens in *Calcination*, that the diſtill'd Matter, tho' drawn from ſolid Bodies, ſuch as *Vitriol*, *Hart's Horn*, and *Bones*, never returns into its former State, but continues in the form of a Fluid. Any one that reflects upon what has been ſaid concerning Coheſion and Fluidity, under the Head of *Calcination*, will eaſily underſtand what Cauſe this may be aſcrib'd to. For in *Diſtillation*, not only the finer Parts are divided from the groſs, but they

are entirely abſtracted from the Union of others, and lie in a Body by themſelves. So that the Diſtill'd Liquor, being nothing elſe but a Collection of Fluid Parts, muſt always of neceſſity retain its Fluidity.

I doubt not but you have obſerv'd, that there is a difference in the Elevation of the *Phlegm*, which in ſome Experiments riſes before the *Spirit*, and in others after it. The one is remarkable in diſtilling the *Acid Spirits of Vitriol*, *Salt*, and *Nitre*; the other in diſtilling *Burning* and *Urinous Spirits*, as thoſe of *Wine*, and of *Sal Armoniac*. Tho' the Reaſon of this Variety may be deduc'd from what has been ſaid, yet it may not be amiſs juſt to touch upon the Explication of it here. Now this ariſes intirely from the Specifick Gravity of the Fluids; for if we make the Experiment, we ſhall find

Phlegm

Phlegm is ſpecifically lighter than thoſe *Acid Spirits*, and heavier than the *Urinous* and the *Burning*. Since *Tab.* 3. therefore the Levity of Bodies cauſes them to aſcend ſooner, it is very plain why there ſhou'd be ſuch Variety in the aſcent of *Phlegm*. Nor does it any way contradict what we have advanc'd, that in the *Diſtillation* of *Animals*, as of *Hart's Horn*, *Vipers*, and *Human Skull*, the *Phlegm* comes off before the *Spirit*, tho' the *Spirit* is lighter than the *Phlegm*. For we muſt take notice, that the *Salts* and *Spirits of Animals*, thoſe eſpecially which are contain'd in *Bones* and *Horns*, are lock'd up and confin'd in certain little Cells, which muſt be firſt broke open, before they can be at liberty to aſcend. But the *Phlegm* being diffus'd every where, even in the Superficial Parts, is ſooner drawn out, and carry'd off by the Fire, tho' it has a greater

Specifick Gravity than the *Spirit*. And the Truth of this is evident from the Second *Diſtillation* of theſe *Spirits*, which is call'd *Rectification*, for here the *Spirits* riſe before the
Tab. 1. *Phlegm*, being freed now from thoſe Cells, which confin'd them before.

In *Oils*, 'tis very particularly obſervable, that tho' they be much lighter than *Water*, and boil and rarefy ſooner, yet (contrary to what is generally deliver'd) they are not
Tab. 2. ſo ſoon elevated by the *Retort*. But this depends on the various Texture of both; for the Globules of *Water* cohere more laxly, and therefore more eaſily ſuffer themſelves to be ſeparated. But the Parts of *Oil* are ſo tenacious, and ſo link'd to one another, that they cannot be divided, and carry'd upwards, unleſs the Impetus be very ſtrong. For this reaſon it is, that the more thoſe *Oleoſe Liquors* are

depriv'd

depriv'd of their *Oil*, with ſo much the more facility they aſcend, as we Experience in the *Spirit of Wine* and *Turpentine*.

The Uſe of *Diſtillation* is well enough known; namely, that the Liquid Parts may be ſeparated from the more Compact, whether they come out in the form of *Oil*, *Phlegm*, or *Spirit*. But as to what concerns the *Apparatus*, in this Proceſs, and the Mixing, as we ſometimes do, another Body with what is to be Diſtill'd, will come more properly under our Conſideration, when we treat of the Doctrine of *Sublimation*. In the mean time, you will be better able to judge of the Truth of what has been ſaid, if you *conſult this Table of Rarefaction*. *Tab.* I.

The Fourth Lecture.

Of Sublimation.

Sublimation differs very little from *Diſtillation*, excepting that in *Diſtillation* only the Fluid Parts of Bodies are rais'd, but in *this* the Solid and Dry; and that the Matter to be Diſtill'd may be either Solid or Fluid: But *Sublimation* is concern'd only about Solid Subſtances.

There is alſo another difference, namely, that *Rarefaction*, which is of very great uſe in *Diſtillation*, has hardly any room in *Sublimation*; for the Subſtances, which are to be *Sublim'd*, being Solid, are incapable of *Rarefaction*; and ſo 'tis only *Impulſe*, which can raiſe them. It being therefore *Impulſe* alone, which

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is the cauſe of the Aſcent of Bodies, we are now talking of, the Nature of this Operation may be clearly deduc'd from what we have ſaid concerning *Impulſe*.

However, it may not be improper to enquire a little more nicely into the Reaſon of ſuch a Diverſity in the Elevation of Bodies, why ſome do aſcend with a gentle Heat, and others are not to be rais'd with the moſt vehement Fire. And ſuch an Enquiry will more properly come in here, becauſe this Head contains all the buſineſs of *Volatility* and *Fixation*, concerning which ſo much has been writ by the *Chymiſts*, and ſo little to the purpoſe.

Fixt Bodies are ſuch as abide the *Fire*; *Volatile*, ſuch as not being able to endure the Fire, are rais'd by the Force of its Heat. We will therefore begin with the firſt, and explain the Manner, how in *volatile Subſtances*,

ſtances, which ſeem to be of the ſame Nature, there happens to be ſo great a Variety and Difference of Elevation.

The cauſe of this Elevation and Aſcent in the Particles of Bodies is to be aſcrib'd to the Fire, not only on the account of *Impulſe*, but of another Property the Fire has, namely, to inſinuate it ſelf into all the Interſtices of theſe Bodies, and thereby break the Coheſion of their Parts, ſo that they are at laſt divided into very ſmall Parts, if not into the ſmalleſt, which Art can reduce them into. Particles thus ſeparated and divided, loſe much of their *Gravity*, as we took notice of before. For the *Gravity* of the ſame Particle decreaſes in the ſame Proportion, as the Cube of its Diameter is leſſen'd. Let us therefore take a Body, whoſe Diameter is 12, and its Gravity 12. If then its Diameter be

be made leſs by 1, (*viz.* 11.) the *Gravity* of that Body will be only $9\frac{1}{4}$, or thereabouts: For 1331, which is the Cube of the laſt Diameter, bears the ſame proportion to $9\frac{1}{4}$, which 1728, the Cube of the firſt Diameter, does to 12, the *Gravity* of the Body. But if the Diameter be reduc'd to 10, the *Gravity* will but juſt exceed 6; and if it is diminiſh'd *half*, that is to 6, then the *Gravity* will be leſs than 2. So that very minute Corpuſcles, when their Diameter is leſſen'd as much as may be, have ſcarce any *Gravity* at all. Therefore when once they are divided after ſuch a manner, as we have deſcrib'd, they are very eaſily ſublim'd.

Nor does there only a decreaſe of *Gravity* follow from this Diviſion of the Particles of Bodies, but there is another thing too, which is the reſult of it, that conduces very much

much to quicken the Aſcent: and that is, the Variety of their *Surfaces*; *For the Surface* of a Body decreaſes in a very different manner from *Gravity*, *only as the Square of the Diameter is leſſen'd.* To look back therefore upon what we have ſaid above, where the *Gravity* decreaſes in ſuch a Series, as is expreſs'd by the Numbers 1728, 1331, 1000, we ſhall find the Diminution of the *Surface* will obſerve this proportion, *viz.* 144, 121, 100. And when upon reducing the Diameter to 6, the *Gravity* will be leſs than 2, the *Surface*, will ſtill amount to 36. So that tho' the *Gravity* of a Particle be ſo leſſen'd, as to be reduc'd almoſt to nothing, yet there will be *Surface* enough left, which will ſerve to raiſe it. This Argument, which we have drawn from the Largeneſs of the *Surface*, and which we have explain'd by Calculation,

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may be demonſtrated, as it were to Senſe, by the following Experiment. If *Water* be pour'd upon the *Filings of Iron*, and a little *Oil of Vitriol* dropt upon it, a Fermentation will preſently ariſe, and you'll ſee that the Globules of Air, in ſtriving to diſengage and extricate themſelves, will carry up with them ſome of the Particles of *Iron* to the Surface of the *Water*. This can happen upon no other account, but that the Proportion of Gravity in the *Filings of Iron*, is very ſmall in reſpect to the largeneſs of their *Surface*, and therefore *Iron* is forc'd upwards by a Body, which is a great deal ſpecifically lighter than it ſelf. But how much this muſt contribute to a more quick Aſcent, has been in general explain'd already, and will be much more evident to our Senſes from the Sublimation, *Camphire*, *Benzoin*, and *Arſenic*, whoſe Particles as they cohere

cohere but looſely, are for that Reaſon diffus'd into a larger *Surface*; upon which account they are the eaſieſt to be ſublim'd of any. Nay, theſe Solid Particles, upon account of their *Surface*, will ſooner aſcend than ſome Fluids. So *Flower of Sulphur* riſes ſooner than *Oil*, not only that of *Vitriol*, but any other, tho' never ſo light. By this Contrivance of Nature, *viz.* that the Gravity of Bodies decreaſes in a *Triplicate*, but their Surface in a *Duplicate* Proportion of their Diameters, it comes to paſs, that Bodies, which have a very different Gravity, may be rais'd with the very ſame Force. Thus the *Salts of Animals*, as of *Hart's Horn*, *Human Blood*, of *Vipers*, &c. being compos'd of very minute Corpuſcles, as we find by Experience in *diſtilling* them, do eaſily aſcend, becauſe the *Surface* in them is not leſſen'd ſo much as the *Gra-*

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vity is. And the *Salts* of *Vegetables*, as of *Tartar*, and *Balſam*, &c. which are of a more cloſe Texture, by reaſon of their large Surfaces, are without much difficulty rais'd. The Corpuſcles alſo of *Minerals* and *Metals*, tho' very compact and heavy, do in ſome meaſure give way to the Fire, and are capable of being ſublim'd. In all theſe Inſtances the breadth of the *Surface*, which expoſes the Particles more to the Impetus of the Fire, is the reaſon why they are rais'd with as much eaſe, as if their Gravity had been leſſen'd by diminiſhing their Surface. So that Particles, tho' never ſo different in Weight, may be equally rais'd by the ſame degree of Heat, if the Proportion of their Gravity be reciprocal to that of their Surfaces. From what has been thus at large explain'd, we may eaſily deduce the Reaſon of all that Variety

riety, which we obſerve in the *Volatility* of Bodies. As for *Fixation*, we need not ſay much of it, ſince it is owing to juſt the contrary Cauſes. For he that thoroughly underſtands, why ſome Subſtances can be *Sublim'd*, muſt of courſe, at the ſame time, apprehend why others can't.

It will not be thought, I believe, a Digreſſion, to ſay ſomething concerning *Mercury*. Which, tho' the Bulk of its Particles be extremely minute, yet becauſe the Surface of 'em is very little, and Gravity very conſiderable, is very difficultly *ſublim'd* by its ſelf; tho' 'tis erroneouſly reckon'd by many among thoſe Bodies, which are moſt *Volatile*. If we mix a little *Lead* with it, 'twill riſe ſomewhat quicker: For by this Contrivance, the Texture is ſo chang'd, that the Surface is enlarg'd in the ſame Proportion as the Gravity is leſſen'd. By the

ſame

ſame Rule *Cinnabar*, made of *Antimony* and *Mercury*, is more eaſily ſublim'd than the foregoing Mixture. So *Mercurius Dulcis* (in which Compoſition the *Acid Salts* are mix'd with the *Mercury* in almoſt equal Proportion) riſes ſtill much ſooner. And *Corroſive Sublimate*, where the Salts *thrice* exceed the quantity of the *Mercury*, riſeth ſooneſt of all. And upon this depends all that Myſtery of the *Chymiſts*, whereby *Volatiles* are *fix'd*, and *fix'd Bodies volatiliz'd*. For firſt of all, they take care to mix with the *volatile* Body one that is *fix'd*, and which will endure the Fire, as *Acids* with *Urinous Salts*; by this means, the *Urinous Salts* uniting with the *Acids*, form new Bodies, and the Gravity and Coheſion of their Parts are very much increas'd, and therefore don't ſo eaſily give way to the Fire. In the ſame

manner *Volatile Acid Spirits* are hinder'd from riſing, when mix'd with *fix'd Salts.* Nay, thoſe very Bodies which, when ſeparate, do very readily aſcend, may be ſo blended, and cloſely join'd together, as to elude the Force of the Fire, upon account of their Coheſion. Of which we have plain Inſtances in *Bezoar* and *Turbith Mineral.* On the other hand, in order to make fix'd Bodies riſe, they add ſome *volatile* Subſtance to them, as *Sal Armoniac* to *Steel and Copper.* For by this Mixture, the Gravity of the Compound is leſs than that of the *Metal*, and therefore the Sublimation is eaſier. 'Tis after this manner that Monſieur *Homberg* teaches us to make the *volatile Salt of Vitriol*, by mixing *Borax.* In ſhort, *Volatile Bodies* don't ſeem to differ from *fix'd*, any otherwiſe, than that they are compos'd of much more *minute* Particles *Volatility*

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Volatility and *Fixation* ſeem to regard *Salts*, more than other Bodies. Tho' I don't know but thoſe *Salts* which are taken for *fix'd*, are ſuch as may be ſublim'd by a more violent Fire, or by length of Time. For if *Calcin'd Salt of Tartar*, than which none is accounted more *fix'd*, be kept a conſiderable time in a Vial, it will cover, and as it were incruſtate the Glaſs Stopple with *Cryſtals*. And Mr. *Boyl* raiſes the ſame Salt in a Retort, by a particular Method. And the ſame accurate Obſerver in Chymiſtry does very juſtly take *Volatility* and *Fixation*, not ſo much for *Abſolute*, as *Relative* Things.

But perhaps we ſhall more clearly perceive the Truth of what has been deliver'd, if we do but examine a little ſome Proceſſes, which we have already gone through in *Diſtillation*. To extract *Spirit of*

Nitre, we mix a *third part* or more of ſome kind of *Bole* with the *Salt Peter*; by the Addition of which, not only the *Melting* of the *Nitre* is prevented, but its *Coheſion* is ſo broken, that it gives way with more eaſe to the Fire. After the ſame manner the *Spirit* and *Oil* of *Amber* are drawn; and *Common Salt*, which, if manag'd as the *Nitre* was, wou'd not yield its *Spirit*, unleſs in a *Reverberatory* Fire; when 'tis divided and broken with *Oil of Vitriol* and *Water*, will diſtil by the *warmth of a Sand Furnace* only. So if *Water* be pour'd upon *Sal Armoniac* the Particles will be ſo looſen'd and disjoin'd, that the *Spirit* will ſooner come off. By a like method, when we extract the *ſweet Spirit of Salt*, or *Nitre*, the Saline Liquor, by the Mixture of *Spirit of Wine*, is made both lighter, and more apt to rarefy, and the Salts themſelves are reduc'd

duc'd into ſmaller Particles, from whence follows a more expeditious Aſcent.

Thus we have explain'd, in ſome meaſure, thoſe *Operations of Chymiſtry*, which belong to the Claſs of *Diſſociation*. Concerning which, we may make this general Remark, That tho', during the Operation it ſelf, we may ſeem as if we intended rather to *compound* than *ſeparate* Bodies, as when we add to, or mix any thing with them, yet the Deſign of the Operation is, that ſome Parts ſhou'd be disjoin'd and remov'd from others, with which they formerly coher'd. So that when we are to make a Judgment of the Nature of theſe Operations, we muſt not ſo much regard the Preparatory Methods we take in any *Proceſs*, as what we gain at the End of it.

The Fifth Lecture.

Of Fermentation.

THE *Fermentation* we here undertake to Explain, is that Inteſtine Motion of Parts, which ariſes upon the Diſſolution of Solids in *Liquors* or *Menſtruums*. This Motion is ſometimes ſo gentle, as to be quite imperceptible; and at other times ſo ſtrong, as to come under the Notice of our Senſes. The firſt kind of *Fermentation*, we will take leave to call *Diſſolution*; but the ſecond, *Ebullition* or *Effervescency*.

That we may the better form ſome Idea of the Nature of this Operation, we ſhall diſcourſe of the *Diſſolution of Salts*, which is the moſt ſimple kind of all; and from the Deſcription of this, you will eaſily imagine

imagine to your ſelves, in what manner the other ſorts of Solutions are done. In order to its better Explication, we ſhall firſt enquire, by what cauſe the Motion of theſe *Salts* is produc'd; and in the next place, how they are diſſolv'd by this Motion.

This Motion therefore may very well be accounted for, from an *Attractive Force*, which is ſo very extenſive in *Natural Philoſophy*, that there is no kind of Matter in the whole Univerſe, but what is ſubject to it. We are to take notice then, that the Corpuſcles of *Salts*, which are the moſt ſimple of any, (tho' at laſt, when they are left to *Cryſtallize*, they unite into *Moleculæ* full of Pores) are withal very minute, and for their Bulk very ſolid; and therefore exert a very ſtrong *Attractive Force*, which, *ceteris paribus* is proportional to the quantity of

Matter. Hence it comes to pass, that the Particles of *Water* are more strongly attracted by the *saline* Particles, than they are by one another. The Particles of *Water* therefore cohering but loosely, and being easily moveable, approach the Corpuscle of *Salt*, and run as it were into their Embraces; and the Motion of them is quicker or slower, according to their less or greater distance; the *Attractive Force* in all Bodies being strongest at the Point of *Contact*, as the Mathematicians have demonstrated. Therefore, if you throw *Salt* into the middle of a Dish full of *Water*, we shall find the *Aqueous* Particles, which are in the middle of the Dish, will be sharp and pungent to the Taste: But the Water upon the *Sides* of the Vessel continues almost insipid. So that when such a Motion once arises, the Aqueous Particles are carry'd with some Force

Force towards the *Salts*, and the Moment of them is to be eſtimated, as *Mechanicks* teach us, *from the Ratio of their Weight and Celerity conjunctly*. By the Force of this Impulſe, they open themſelves a Paſſage into the Pores of the *Salts*, which are very numerous; and at length they ſo break, and divide their Texture, that all Coheſion of their Parts is deſtroy'd; hereupon, being ſeparated, and remov'd to a convenient diſtance from one another, they are diſpers'd, and float here and there about the *Water*. Thus we find how the Solution of *Salts* is to be accounted for, from an *Attractive Force*. And this we not only deduce by Reaſoning, but can evince by Ocular Demonſtration. For we plainly ſee, that when *Sugar* is put into *Water*, the Aqueous Particles will riſe up immediately, and by degrees inſinuate themſelves into

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the Parts of the *Sugar*, which are above the Surface of the *Water*. This *Attractive Force* is likewiſe demonſtrated from *Oils*, which are made *per Deliquium*; for by this Force it is, that they continually abſorb, and draw in the Moiſture of the Air. Upon this too, ſeems to be grounded the Reaſon of that *Proceſs*, which ſome obſerve in *Oil of Sulphur*. For in the bottom of the Pot, in which the *Sulphur* is to be ſet on Fire, they place the *Calx of Cryſtal*, which they do upon no other account, but becauſe the *Calx* may imbibe and ſuck in all the *Phlegm*, and by that means make the *Oil* ſtronger, or as the *Chymiſts* Phraſe it, more *Concentrated*.

But in the Solution of theſe *Salts*, we meet with ſome Variety; for ſome, ſuch as *Nitre*, and *Sal Armoniac*, &c. require a leſs time to diſſolve them; but others, ſuch as

Common

Common Salt and *Vitriol*, a longer. And there is alſo another Difference in *Salts*; for ſome will diſſolve in a leſs, others in a greater proportion, in the ſame quantity of *Water*. So that if we wou'd compare the Weight, between the *Water* and the *Salts*, we ſhall find by Experience, that *Common Salt* diſſolves, but in a *half* proportion, *Alum* and the *Sal Enixus* of *Paracelſus* in almoſt an *equal*, and *Sugar* in a *double*. This Variety of Solution does not proceed from the *Water*, which is perfectly the ſame, in all theſe Inſtances, but from the different Coheſion of the *Salts*; for ſuch as are of a rarer Texture, as Sugar ſeems to be, are more eaſily broken in pieces by this Inteſtine Motion, and ſo melt in larger Quantities.

The *Chymiſts* have a particular kind of Solution, which they call *Deliquium*; that is, when *Salts* diſſolve,

ſolve, upon being expos'd to the open Air. This Solution is made juſt after the ſame manner as thoſe we have already mention'd. For 'tis owing to the *Aqueous* Particles, which the Air abounds with, that *Salts* thus expos'd do melt. And this we may be convinc'd of, from a conſtant Obſervation, that nothing more promotes and haſtens this kind of Solution, than the moiſture of the Place and Weather. Hence the Water, which is thus contain'd in the Air, is the occaſion of the increaſe of Weight in the *Salts*, when they are diſſolv'd; ſo that for Inſtance, from an Ounce of *Salt of Tartar*, you ſhall have two Ounces of *Oil*. Juſt ſo too, does *Oil of Vitriol* gain in weight, when 'tis ſet in the open Air. But if Salts be firſt reduc'd to *Cryſtals*, they will hardly yield to a Solution, *per Deliquium*, by reaſon of their greater Coheſion,

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and conſequently a ſtronger Reſiſtance to any outward Force. And thoſe Salts which are extracted from the Aſhes of Plants, and call'd *Alkalizate*, tho' they diſſolve in the open Air the eaſieſt of all, yet if once *Cryſtalliz'd*, will not melt but with the utmoſt difficulty. But this we muſt obſerve concerning theſe Solutions, that by application of Fire, they are all perform'd ſooner, and in larger quantities. For the Igneous Particles do not only break and deſtroy the Coheſion of the *Particles* of *Salt*, but alſo increaſe the Moment of the Aqueous Particles, and by that means aſſiſt them. The ſame is to be ſaid of any other Motion and Agitation whatever.

'Tis a common Notion, that tho' *Water* be impregnated with one *Salt*, till it can take no more, yet after that, it may imbibe ſome of another kind. This, as affirm'd of *Salts* in general,

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may with good ground be doubted. For in the very Experiment, they here give us, they take for granted, what ought firſt to be prov'd, while they let the Water lie a long while upon the Salt, in order to make the Solution more ſaturated. For when the Solution has ſtood a conſiderable time, a great part of thoſe Salts, which firſt floated in the Water, ſubſides and turns to Cryſtals. So that the Water is ſo far from having imbib'd all the Saline Particles it cou'd, that if you ſhou'd again add ſome more of the ſame kind of Salt, it will without any difficulty abſorb that too. And if the Experiment be made after this manner, why may not we ſuppoſe, that it may as well be capable of receiving ſome Saline Particles of another kind? However, I don't deny, but it may ſometimes happen, that *Water*, when it can take in no more of ſome

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kinds of Salts, yet will very readily admit ſome of another kind; as we find *Sugar* will diſſolve in the ſtrongeſt Solution of *common Salt* that can be made. Nor is this any ways inconſiſtent with Reaſon: For ſince there is ſuch a variety in the Coheſion of Salts, the Water muſt naturally leave that untouch'd, which is of a more firm Texture, and diſſolve and imbibe that, which is of a more looſe one. But it can be hardly thought, that this can ever be the cauſe, in thoſe that are of the very ſame Texture. This will appear more clearly to us, if we make a nicer Enquiry into the Reaſon, why only a certain determin'd quantity of Salts can be diſſolv'd. For when a good part of the Saline Body is melted down in the Water, thoſe Corpuſcles, which are already diſſolv'd, attract one another every way, ſo that the mutual Attraction

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of the *Aqueous* Particles among themſelves grows much ſtronger: When, in the mean time, the Motion, which at firſt they exerted upon the undiſſolv'd Maſs, is ſo broken and languid, that at length it quite ceaſes. For all the Motion, which was firſt rais'd, was owing to the *difference*, which is between the *Attractive Force* of the *Water*, and that of the *Salt*. Therefore when the Attraction is equal on both ſides, the Motion muſt ceaſe, and ſo there can be no further Solution. This will make us underſtand, why we may uſe an indefinite quantity of *Crocus Metallorum*, in the making of *Emetic Wine*; for put in as much Powder as you pleaſe, only a certain Portion of it will be diſſolv'd. Upon this account, the Doſe of a Vomit is determin'd, not from the quantity of the *Crocus*, but from the quantity of *Wine*.

Salts are commonly reduc'd into *Powder*, that they may diſſolve more eaſily; by which means, not only the *Coheſion* is leſſen'd, but the *Attraction* is increas'd. For by this Contrivance, a greater Number of Particles are expos'd to the *Menſtruum*, and by their united Forces, attract the Water more ſtrongly. For the ſame Reaſon it is, that we beat the harder Bodies into Plates; or take the Filings of them, that they may be more eaſily *corroded* by the *Acids*.

By theſe Principles, we may account for the *Solution* of all other Bodies: To Explain which exactly, we muſt conſider, not only the *Force of Coheſion, and Magnitude of the Pores*, in the Body to be diſſolv'd, but the Aptneſs to Motion, and the Strength of Moment in the *Menſtruum*. We muſt alſo have regard to *Elaſticity*, as will appear in its

proper Place. If all theſe Particulars cou'd be accurately determin'd and ſettl'd, they wou'd very eaſily let us into the Reaſons of all that Variety, which is obſerv'd in Solutions. Let us take for inſtance, *Water* and *Spirit of Wine*, whoſe Natures are very different; for *Salts* will eaſily diſſolve in the firſt, becauſe the *Aqueous* Particles are more ſtrongly Attracted by the *Saline* Corpuſcles, than they are by one another: Whereas in *Spirit of Wine*, which is indeed much lighter than *Water*, but more impregnated with Saline Particles, they continue untouch'd. So that the Particles of the *Spirit*, upon account of the minuteneſs of their Bulk, attracting one another more ſtrongly, than they do the *Salts*, are not able to break the Coheſion of the Particles of *Salt*. From the ſame Cauſe it is, that the Feathers of Water-Fowl,

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and Fat Subſtances, have no Moiſture ſtick upon them, when they are put into Water. On the contrary, *Spirit of Wine* eaſily diſſolves *Roſins*, which *Water* can by no means do; the Particles of *Roſin* ſeem to be ſo cloſely united and compact, as to leave but very ſmall Interſtices, into which the Corpuſcles of the *Water* can't enter, but thoſe of the *Spirit* can very eaſily, becauſe their Bulk is ſo much ſmaller. After this manner is the *Amalgamation* of Metals to be accounted for. For Inſtance, Gold appears to be compos'd of Corpuſcles, which attract very ſtrongly; hence it eaſily admits the Particles of *Quickſilver*, which are attracted with greater Force by the Gold, than they are by one another; and beſides, are ſo minute, as to enter the Pores of the Metal without any difficulty. The attractive Force in the Particles of

Silver come neareſt to that of *Gold*, therefore it ſooner yields than other Metals, when *Quickſilver* is mix'd with it. But the Attractive Force of *Iron* and *Braſs*, hardly exceeds that of *Quickſilver*; for which Reaſon 'tis, with abundance of difficulty, that they are *Amalgamated* with it, unleſs the *Mercury* is made to loſe ſome of its Attractive Force, by the mixture of ſome other Body.

Corroſion, with the *Chymiſts*, is a Diſſolution of Bodies, either by an *Acid*, or *Saline Menſtruum*; ſo that what we have already ſaid, will afford us ſome Aſſiſtance in Explaining this too. This is peculiar to *Corroſion*, that it is almoſt wholly deſign'd for the Reſolution of Bodies, which are more ſtrongly compacted, ſuch as *Bones* and *Metals*: So that *Saline Menſtruums*, ſeem to have a very conſiderable Moment or Force; the Reaſon of which it may not be

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amiſs to trace out more diſtinctly. Theſe Liquors, whether *Acid* or *Urinous*, are nothing but *Salts* diluted with a little *Phlegm*. Therefore theſe being Solid, and conſequently containing a conſiderable Quantity of Matter, do both *attract* one another more, and are alſo more *attracted* by the Particles of the Body, which is to be diſſolv'd. For this is one of the Laws of *Attraction*, viz. *That if the diſtances be equal, 'tis proportional to the quantity of matter contain'd in the Attractive Particles.* So that when the more Solid Bodies are put into *Saline Menſtruums*, the *attraction* is ſtronger here than in other Solutions; and the Motion, which is always proportionable to the *attraction*, more violent: And we may eaſily conceive, how when the Motion is increas'd in this manner, it ſhou'd drive the *Salts*, like ſo many Darts, into the Pores of the

Bodies, and open and looſen the Coheſion of them, tho' never ſo firm. And we are to obſerve this in *Corroſion*, that the more minute the Particles of the *Menſtruum* are, they penetrate the ſooner, and with the greater Force: For the Motion, which Attraction produces, is always greateſt and moſt conſiderable in the leaſt Corpuſcles, and is almoſt next to nothing in the larger ones. For a ſmall Corpuſcle is carry'd with a conſiderable Velocity, when a greater, by reaſon of its large Surface, is often obſtructed by the Ambient Fluid, and depriv'd of all Motion. And there is another advantage gain'd by this Minuteneſs of the Particles, that they approach nearer the Body, which is to be diſſolv'd, without which the attractive Force will not be felt. 'Tis a true Axiom therefore of the *Chymiſts*, that *Salts will not act, unleſs diſſolv'd.* Hence thoſe

thoſe very *Salts*, which diſſolv'd in *Water*, will hardly touch *Metals*, if once turn'd into *Acid Spirits*, will eaſily penetrate, and conquer them. For in *Diſtillation*, not only a leſs quantity of Water remains, but the Saline Bodies are ſo minutely divided and broken, by the Fire, as to make them more readily capable of being mov'd by an *Attractive Force*; therefore ſuch a *Diſtill'd Menſtruum* is much more efficacious, than any Solution of *Salt*, made with Water.

But if thoſe Particles, which are thus put in motion, are *Elaſtick*, then the *Fermentation* will be evident to Senſe. For Particles, which are entirely *Elaſtick*, recede from one another, after they have met, with the ſame Celerity they had before they met. In Particles therefore of this kind, a new degree of Motion will be acquir'd, after every Congreſs, and the Conflict will be ſtill

more violent; ſo that at length their Impetus and Moment will be ſo great, as to break and deſtroy the hardeſt Bodies. And ſince this Force of *Elaſticity* is attended with that of *Attraction* too, the Motion will increaſe yet to a greater degree; for the Impetus of a Particle, which is reflected againſt another, indu'd with an attractive Force, is continually augmented, by the *Repercuſſion*. Particles thus agitated, endeavour to drive out and exclude all the *Air*, which is contain'd in their Pores. And the *Air* being rarefy'd by this Colliſion, ſo as that it cannot, upon account of its Levity, keep its former place, carries up with it thoſe Globules of Water, which inclos'd it, to the Surface, and there forms *Bubbles*. We have before mention'd an Experiment, which will give the beſt Light into what we have ſaid; for if you put the *Filings of Steel*,

Steel, after you have pour'd *Water* and *Oil of Vitriol* upon them, into an *Air Pump*, when the External Air is gradually exhauſted, all that Air, which is contain'd within the Pores of the *Steel* and *Water*, will burſt out with ſuch a Force, as not only to raiſe a prodigious Froth on the Surface of the Liquor, but even to drive the Liquor over the Brim of the Glaſs.

If this Motion increaſes to a very high degree, it raiſes an *Effervescency* and *Heat*, which is nothing elſe but a more rapid Motion of Parts, produc'd by their mutual Attrition. And that we may the better conceive this, let us examine how an *Effervescency* is produc'd, by mixing of different Liquors, as *Water* and *Oil of Vitriol*. In this *Oil* there is ſuch an abundance of Salts (as is evident from its *Gravity*) that they ſeem to be plac'd cloſe to one another;

and

and upon this account, becauſe the Attraction is diffus'd equally every way, they continue as it were in an *Equilibrium*; but when the *Water* is pour'd upon it, the Contact of the Salts is taken away, and the Attraction becomes unequal. Theſe Salts, according to their Natural Propenſity, ſtrive to unite again; and ſince, by reaſon of the quantity of Matter they contain, they attract one another more than they do the *Water*, they diſplace the *Water*, and force it out of their Intervals, until ſuch time as the *Oil* is diluted every where alike, then the *Fermentation* ceaſes. But if the *Salts* are *Elaſtick*, which is very probable, ſince there is ſcarce any Body entirely void of *Elaſticity*, they will not only ruſh upon one another with Violence, but after the Stroke recoil, and move in a contrary direction: From hence proceeds the reciprocal

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Fluctuation of Parts, which we obſerve every way, and at length an *Effervescency*. And thus this kind of *Fermentation*, uſually aſcrib'd to I know not what *Antipathy*, between an *Acid* and an *Alkali*, may mechanically enough be accounted for.

That this *Fermentation* is rais'd by *Elaſtick Particles*, is very probable, becauſe all Bodies *ferment* more ſlowly, when debarr'd from the Air, which all allow is *Elaſtick*. So that to make *Ale ferment* well, we mix it with *Yeaſt*; a *Ferment* which abounds with *Air*. Likewiſe the *South-wind*, does not only give the firſt *Effervescence* to potable Liquors, but does alſo raiſe a new *Fermentation* in 'em, at ſome diſtance of time afterwards. Nor does that conſiderable *Rarefaction*, which is remarkable in *Fermentation*, a little favour this Theory; for no Bodies can be rarefy'd to that degree, unleſs they

they have ſome *Air* included in them, as is generally the caſe of all Fluids whatever. But no Argument can make more for us, than one which may be taken from *Salt of Steel*. For it is notorious, that *Steel* is very *Elaſtick*; 'tis for this Reaſon then, very probably, that an *Effervеſcence* follows upon mixing it with *Oil of Vitriol*. But yet if you add *Water* to this Mixture, it will cauſe a more violent Heat, and ſo diſſolve the *Iron* ſooner, contrary to what ſome have affirm'd. *Spirit of Vitriol*, which has a large Proportion of *Water*, if mix'd with the *Oil*, does the ſame thing. The Reaſon of which Appearance ſeems to be this, That in *Oil of Vitriol*, when 'tis well freed from the *Phlegm*, the *Salts* are ſo condens'd and compact, that they may be ſaid to lie and reſt upon the *Iron*; and ſo being almoſt without any Motion, cannot make

make any conſiderable Impreſſion upon it: But upon pouring on the *Water*, they are not only more broken and ſeparated into leſſer Corpuſcles, by which means they attack the Iron with a greater Velocity, but likewiſe they are more attracted by the Particles of the *Iron*, than by one another, which increaſes the Inteſtine Motion. Upon this Conſideration, the *Chymiſts*, for the better performing the Solution, weaken the *Menſtruum*. For double *Aqua Fortis* does not diſſolve *Silver* ſo well, as that which has more *Phlegm* in it. And ſometimes *Spirit of Wine*, the more rectify'd it is, the more unfit it is for extracting *Tinctures*. In like manner *Braſs*, *Mercury*, and a great many other Bodies, mix'd with *Oil of Vitriol*, will ſcarce cauſe any *Fermentation*, but will ferment and froth very much, when mix'd with *Spirit of Nitre*,

Nitre, which is a much weaker *Menſtruum*. On the contrary, if too much *Phlegm* be added, it will entirely check the *Fermentation*. For this Reaſon, *Spirit of Vitriol*, if it be weak, raiſes no *Effervescency* with *Iron*; and the ſame thing happens too in the Experiment with *Oil of Vitriol*, if you pour too much Water upon it. For the *Menſtruum* being thus diluted, the Particles of Salts are ſeparated, and removed from one another, ſo far, as to be out of each others *Sphere of Attraction*. So that in all this Operation, both an *Elaſtick*, and an *Attractive Force*, are neceſſary Aſſiſtants: And all that Variety, we ſee in *Fermentation*, is owing to the different degree of them. Hence it is, that oftentimes new Bodies ariſe during *Fermentation*; for the former Texture is entirely alter'd and chang'd, by the continual Colliſion of the Parts.

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There has been a great deal writ by Authors, and many Diſputes maintain'd by them, concerning the Difference of *Menſtruums*; and there is hardly one of 'em, who has not invented ſome Hypotheſis, in order to demonſtrate, why ſome Bodies diſſolve in a *Saline Menſtruum*, as *Metals*; others in a *Sulphureous*, as *Roſins*; and others again in an *Aqueous*, as *Salts*. Particularly great Controverſies have been about *Aqua Fortis*, and *Aqua Regia*: Why the firſt diſſolves *Silver*, and not *Gold*; and why the latter diſſolves *Gold*, yet does not touch *Silver*. But all which they advance to ſolve this *Phænomenon*, is ſo very precarious, that their Arguments won't be thought of any force among ſound Philoſophers. This indeed is one of the moſt difficult and abſtruſe Enquiries in *Chymiſtry*; however, if we make uſe of Mechanical Principles,

ciples, I am apt to believe, it is capable of being accounted for, not only from Probable, but Mathematical Concluſions. Therefore, that we may have a better Conception of the whole Matter, let us bring it to a Calculation. It will, I think, be readily granted, that the Cavity of the Pores in *Gold* is not ſo great as that of *Silver*, becauſe its Gravity does much exceed the Gravity of *Silver*. Let us therefore ſuppoſe the *Diameters* of their Pores to be as 2 to 1; then it will follow, that Corpuſcles, fit to penetrate *Gold*, muſt be Eight times leſs than thoſe, that will enter the *Silver*. Let us again ſuppoſe, that the *Attractive Force* in *Gold*, is to that in *Silver*, as 2 to 1, or as 40 to 20. Farther, let the *Diameters* of the Particles, which compoſe *Aqua Fortis*, be twice as big as thoſe of the Pores of *Gold*, ſo that they can never enter or penetrate

netrate it. And let the *Force*, with which *Silver* attracts *Aqua Fortis*, compar'd with the *Force*, whereby the Particles of that *Menſtruum attract* one another, be as 20 to 12, and the *Coheſion* of the *Silver*, to the Moment with which the Particles of the *Aqua Fortis* ruſh againſt it, as 8 to 3; which degree of Force will be ſufficient to make them break the Texture of the *Silver*. Laſtly, ſuppoſe the *Coheſion* of the Particles of *Gold*, to be to that of *Silver*, as 3 to 2. Upon diſſolving *Sal Armoniac* in *Aqua Fortis*, there ariſes, as is well known by Experience, ſuch a Vehement *Fermentation*, that unleſs it be pour'd on leaſurely, by little and little, the Glaſs muſt burſt. So that from this Violent Motion, and the continual Colliſion of the Particles one againſt another, we may very well conclude, their *Diameters* are leſſen'd by half, and

at length become ſo ſmall, as to be capable of entering the Pores of *Gold*. We ſhou'd take notice alſo, that the Force of the *Menſtruum* is much increas'd, when *Sal Armoniac* or *Bay Salt* is diſſolv'd in the *Aqua Fortis*; i. e. the Force whereby the Particles of the *Menſtruum* attract one another, is increas'd by the addition of thoſe Corpuſcles, which are very attractive. Whereas therefore the *Force* of the *Menſtruum* was before as 12, let us ſuppoſe it now to be advanc'd to 16, when the *Aqua Fortis* is made *Aqua Regia*. Hence, if you compare the *Attractive Force*, you will find, that of the *Silver* to *Aqua Regia*, is as 20 to 16; and the *Velocity*, which the Corpuſcles of *Aqua Regia* fall upon the *Silver*, will be proportional to the Difference of *Attraction*, viz. 4. If all the Particles in *Aqua Regia* were juſt as big as they are in *Aqua Fortis*, then their

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Quantity of Motion wou'd bear the ſame Proportion to the Coheſion of the *Silver*, as 4 to 3. But by Suppoſition, each Particle is 8 times leſs, and conſequently muſt have but the 8th Part of the Moment: So that the Moment, with which the Corpuſcles of *Aqua Regia*, act upon the *Silver*, compar'd with the Coheſion of the *Metal*, will be as $\frac{4}{8}$, or $\frac{1}{2}$ to 3, *i. e.* as 1 to 6. Hence 'tis evident that in theſe Circumſtances, *Silver* cannot be diſſolv'd by *Aqua Regia*. But if we compare the *Attractive Force* in *Gold*, to that in *Aqua Regia*, we ſhall find it as 40 to 16. Therefore the Velocity with which the Particles of it attack the *Gold*, will be as the Difference, *viz.* 24; which Number multiply'd by $\frac{1}{8}$ (*i. e.* the Magnitude of the Particles) will give us the Quantity of Motion, equal to $\frac{24}{8}$, or 3. We ſuppos'd the Coheſion of *Gold* to be 2, which being

exceeded by the Force of the *Menſtruum*, muſt yield to it, and be diſſolv'd. If upon comparing the *Attraction* of the two Metals, that of *Gold* be triple, when the Attraction of *Silver* is 20, that of *Gold* will be 60; and the Difference, which there is between the *Attractive Force* of *Gold*, and *Aqua Regia*, viz. 44. multiply'd by $\frac{1}{8}$ (the Magnitude of the Particles in *Aqua Regia*) will give a Moment equal to $\frac{44}{8}$, or $\frac{11}{2}$: And ſince the Force of Reſiſtance, or Coheſion, is as 2, the Moment will be to that as $\frac{11}{2}$ to 2, or as 11 to 4; that is, it will exceed it almoſt thrice. The Examples we have given may be varied infinite Ways, but it will come to the ſame thing, whatever Numbers are apply'd. But to make the Matter more General, let us ſuppoſe the *Attraction* of *Gold* to that of *Silver*, to be as *a* to *b*; and of *Silver* to *Aqua Fortis*, as *b* to *d*; but that

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of *Aqua Fortis* to *Aqua Regia*, as *d* to *e*. Let *f* ſignify the Magnitude of the Particles in *Aqua Fortis*, and *r*, thoſe in *Aqua Regia*; *c* the Coheſion of *Gold*, and *g* the Coheſion of *Silver*. If the Diameters of the Particles *f*, are greater than the Diameters of the Pores of *Gold*, they can never diſſolve the *Gold*, let their *attractive* Force be never ſo ſtrong. But if $\overline{b - d \times f}$ exceeds *g*, then the Silver will yield to that *Menſtruum*, whoſe Particles are *f*, and leſs than the Pores of the Silver. And if $\overline{b - e \times r}$ is leſs than *g*, the Silver will never diſſolve in that *Menſtruum*, the Particles of which are *r*, and the *attractive* Force *e*. But if $\overline{a - e \times r}$, be greater than *c*, the *Menſtruum*, made up of the Particles *r*, and whoſe *attractive* Force is *e*, will be able to penetrate and diſſolve the *Gold*. Now becauſe,

in this Caſe, the indeterminate Letters are more than the *given Quantities*, it is evident, this Problem may be accounted for ſeveral ways; every one of which will equally ſolve the Queſtion. But as yet we are not fully acquainted with the Proportion there is betwixt the Pores and Coheſion of *Gold* and *Silver*, nor with the Proportion of the *attractive Forces* of the *Metals*, and the *Menſtruums*, which is neceſſary to make this Solution. Tho' perhaps, when Experiments are more accurately made, and examin'd by theſe Mechanical Principles, we may no longer remain in Ignorance about them. At preſent, 'tis enough for our purpoſe, if from Numbers and Calculations, we can point out the Way, which leads us to a Solution of this *Phænomenon*.

The

The Sixth Lecture.

Of Digeſtion.

BY *Digeſtion*, we mean, that Solution of Bodies, which is made by *Menſtruums*, with the aſſiſtance of Fire. The Nature and Reaſon of this Operation having been ſhown, and accounted for, in what we have already deliver'd, 'twill be needleſs to handle it again in this place. For *Digeſtion* hardly differs at all from *Diſſolution*, only that it requires the aſſiſtance of Fire. And how ſtrongly Fire excites an Inteſtine Motion, on which all Solution depends, and how readily it elevates the diſſolv'd Particles, is both explain'd in another place, and ſufficiently underſtood from the Nature of the Thing it ſelf.

So that we hope we ſhall have ſaid enough to explain the Nature of *Digeſtion*, if we ſhew firſt, how the Particles of Bodies, extracted by this Proceſs, can be diffus'd every way, and ſuſtain'd in the *Menſtruum*. And you will think this deſerves to be explain'd and accounted for, ſince theſe ſolid Particles have not the ſame ſpecifick Gravity, as the Liquors have, in which they ſwim. For there can be no Queſtion made about thoſe, whoſe ſpecifick Gravity is the ſame, as that of the *Menſtruum*. It being evident from *Hydroſtaticks*, that they are preſs'd as much as the Parts of the Fluid, and retain whatever Poſition they are put into. But when they happen to be *ſpecifically heavier*, or *lighter*, it is not ſo eaſy to apprehend how they can be ſuſtain'd and ſuſpended; and this is what we ſhall endeavour more fully to illuſtrate and make out.

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Tho' the Nature of a perfectly Fluid Body be ſuch, as that the Particles, which conſtitute it, do very readily give way upon the ſmalleſt Impulſe, and recede from one another; yet there is found in moſt Liquors ſome degree of Tenacity; and from hence ariſes ſuch a Coheſion of Parts, as cannot be broken without ſome Force. And tho' indeed this Force of Coheſion in Liquors ſeems to be but little or none at all, when compar'd with what we experience in Solids, yet we find it can make ſome Reſiſtance. And as the Force in Liquors is either ſtronger or weaker, ſo it produces a Variety of Effects, differing more or leſs from the *Phænomena*, which would naturally flow from a perfect Fluid. So that tho' by the Laws of *Hydroſtaticks*, every Corpuſcle, how ſubtle ſoever, if put into a Fluid, which is ſpecifically lighter, muſt neceſſarily ſink

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to the bottom, yet we find ſome heavy Bodies, ſuch as *Gold*, &c. when reduc'd into thin Plates, or Leaves, will be ſuſtain'd in *Spirit of Wine*. This Force therefore of *Tenacity*, which reſiſts the Motion of Bodies in a Fluid, is proportional to the Number of Parts, which are to be ſeparated, or to the *Surface* of the Body, which we wou'd have move in the Fluid. Hence it is, that ſince the *Surface* of a Body may be enlarg'd, without altering any thing of its *Gravity*, the *Reſiſtance* of a *Fluid* may be ſo augmented, as to equal the *Force of Gravity*, which carries the Body downwards. In order to underſtand this better, let us bring it to a Calculation. Let there be for Inſtance, a *Cylinder of Gold*, In which the *Diameter* of the Baſe, is juſt an Inch, and let us ſuppoſe the *Force of Gravity* in the *Metal* to be to the Reſiſtance of the Fluid in the

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ſame Proportion, as 100 to 1. Now if the *Gold* ſhou'd be form'd into another Cylinder, whoſe Baſe were 10 Inches *Diameter*, then the Surface of this Cylinder, which touches the parts of the Fluid, will be 100 times broader; and conſequently this new Reſiſtance, which the Fluid acquires, will be equal to the *Gravity of the Gold*, and keep it from ſinking. Therefore, by Experiments, we may eaſily find, what degree of Force there is in the Tenacity of any Fluid. Let us imagine an Ounce of *Lead*, in a Cylindrical form, with its Baſe ſo far dilated, till it will no longer ſink in the Fluid, whoſe Tenacity we enquire after. The Baſe of the Cylinder thus dilated is proportional to the Surface of the Fluid, whoſe Tenacity is equal to the Weight of an Ounce. If upon making the Experiment, the Maſs is not obſerv'd

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to deſcend, when the Diameter is reduc'd to 10 Inches, that breadth of the Surface, which is equal to a Circle of 10 Inches Diameter, will have a Tenacity equal to an Ounce; and that part of the Surface, which is equal to a Circle of an Inch Diameter, will be equal alſo to $\frac{1}{100}$ of an Ounce. Theſe things being premis'd, we may ſet the whole Matter of *Digeſtion* in a better Light. A Body, tho' ſpecifically heavier than the Fluid, in which it is immers'd, may be very well ſuſtain'd by that Fluid, provided it be reduc'd into very ſmall Particles. For the *Gravity* of a Body, thus reduc'd into ſmall Particles, decreaſes much in a greater proportion than the *Surface* does; or, which is proportional to it, the *Tenacity of the Fluid*: So that at length, the Reſiſtance, ariſing from its *Tenacity*, will be equal to the Gravity of the Particles, and ſo hin-

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der their descent. Let us therefore suppose a *Sphere of Lead*, of a certain determin'd Diameter, and the Proportion of its Specifick Gravity, to the Tenacity of the Fluid, as 100 to 1. If this Sphere be divided into other little Spheres, whose Diameters are just half as large as the former, then the Gravity of each Sphere will be no more than $\frac{1}{8}$, but the Surface will be $\frac{1}{4}$; *For the Solidity or Gravity of Bodies, decreases in a Triplicate Proportion of their Diameters, but the Superficies only in a Duplicate.* Therefore when the Resistance is reduc'd to $\frac{1}{4}$, and the Gravity to $\frac{1}{8}$, the Weight of each Sphere will be to the Resistance, as $\frac{100}{8}$ to $\frac{1}{4}$ or as $\frac{50}{4}$ to $\frac{1}{4}$, or as 50 to 1. So that in this case the Proportion of the Weight to the Resistance is reduc'd to *half* of what it was before. If a Body be so divided, that the Diameter of each lesser Sphere becomes

comes $\frac{1}{10}$ of the Diameter of the former Spheres, then the Gravity of each of them wou'd decreaſe to $\frac{1}{1000}$, and the Surface or Reſiſtance to $\frac{1}{100}$; therefore the proportion of the Gravity to the Reſiſtance wou'd be as $\frac{100}{1000}$ to $\frac{1}{100}$, or as 10 to 1. And if the Diameter of each Sphere be $\frac{1}{100}$, the Gravity wou'd be $\frac{1}{1000000}$, but the Superfices $\frac{1}{10000}$; therefore the Gravity would be to the Reſiſtance as $\frac{100}{1000000}$ to $\frac{1}{10000}$, which two Fractions being of the ſame Value, the Force of Reſiſtance, in this caſe, becomes equal to the Force of the Gravity; and ſo will keep the Particles from ſinking. And therefore 'tis a general Rule, both in *Solution* and *Digeſtion*, that if the Gravity of a Body is to the Tenacity of the Fluid, as p to 1; and if the Body be then ſubdivided, ſo that the Diameters of the Parts be to that of the whole, as 1 to p, the

p, the Reſiſtance which the Particles will meet with in their deſcent, will be equal to their Gravity; for ſince their Weight is $\frac{1}{p^3}$, but their Surface $\frac{1}{p^2}$, the Gravity will be to the Reſiſtance as $\frac{p}{p^3}$ to $\frac{1}{p^2}$, or as 1 to 1. By this we may underſtand how the Corpuſcles of *Metals* ſwim in *Menſtruums*, which are *ſpecifically lighter*, as *Gold* in the *Spirit of Nitre*, which is drawn off from *Bezoar Mineral*, tho' the Gravity of the *Gold* be 15 *times* greater. For, if we were to compute, we ſhould find, that before the Diameter is reduc'd to half what it was before, as the Gravity of the *Gold* is double in reſpect of the *Menſtruum*, ſo likewiſe the *Surface of the Gold*, compar'd to its *Gravity*, is double. And the ſame Reaſon holds good in almoſt all other *Menſtruums*.

In this manner we have ſeen how

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Corpuſcles, ſpecifically *heavier*, are ſuſpended in *Menſtruums*. 'Tis for the ſame Reaſon, that ſuch as are lighter cannot riſe up to the Surface. For the Preſſure of Fluids being equal every way, the Superior Parts act reciprocally on the Inferior; ſo that the ſame Force, which keeps the heavy Particles from ſinking, will not permit thoſe which are lighter to aſcend. Thus the Particles of *Plants*, as of *Oak*, *Fir*, *Saffron*, &c. tho' their Speci-
* *Tab.* 2. fick Gravity * does not come up to that of Water, yet they are eaſily ſuſpended in it. So *Camphire*, the lighteſt almoſt of all Bodies, diſſolv'd in *Oil of Vitriol*, or *Aqua Fortis*, is ſo preſs'd down by the *Menſtruum*, that it cannot aſcend.

The Uſe of *Digeſtion* may be underſtood from the very Definition of it; namely, to extract the Particles of Bodies, which are more Volatile,

Volatile, and freed from the Terreſtrial ones, by a certain *Menſtruum*, and to mix them intimately with it. To this end a *gentle* Fire is commonly us'd, that the Corpuſcles, which are moſt volatile, may ſeparate as it were of their own accord; for a fierce Fire forces out the *Fæces*, as well as the finer Particles; and if it does not abate the ſtrength of the Liquor, it will not fail of ſpoiling its Clearneſs; a thing which very frequently happens in drawing *Tinctures*. Beſides, if we make the Fire a little too ſtrong, we ſhall hardly prevent an *Empyrema*.

The Reaſon of that Variety, which we obſerve in the *Apparatus* of *Digeſtion*, may be ſufficiently underſtood from what we have ſaid elſewhere. Thus when we melt *Salt of Tartar*, and reduce *Sulphur*, into *Flowers*, to Extract their *Tinctures*,

ctures, we do it for this very Reaſon, that the Particles, being thereby leſſen'd and divided, may more eaſily yield to the *Menſtruum*. *Crocus*, *Opium*, *Caſtor*, &c. whoſe Texture are more lax and rare, do very readily run into *Tinctures*, when the *Menſtruum* is pour'd upon them. *Myrrh* and *Amber*, which are of a more firm Make and Coheſion, and come very near the Nature of *Roſins*, do hardly yield to *Digeſtion*. But if *Sal Armoniac* be mix'd with them, then the *Tincture* is not only extracted ſooner, but made ſtronger, and fitter for Medicinal Uſes. So that *Vigani*'s Opinion of *Myrrh* ſeems very true, that little or nothing is extracted in the common *Elixirs*; therefore he took *Myrrh*, and hung it up in a little Bag, with *Salt of Tartar*, till ſuch time as it grew ſoft; for by this means it diſſolves ſooner in *Spirit of Wine*. This Me-

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thod of *Vigani*'s, in making *Elixirs*, was borrow'd from *Paracelſus*, who ſharpen'd the *Spirit of Wine* with *Oil of Sulphur*.

There is nothing the *Chymiſts* take greater pains in, than in Extracting the *Tincture of Steel*; for in order to diſſolve it, or as they ſay to open it, they have invented various *Menſtruums*, ſome of one kind, and ſome of another, *Urin*, *Verjuice*, *Acid Juices*, *Vinegar*, and *Spirit of Verdegreaſe*, all which do readily penetrate the Body of the Iron, and ſo make it yield a greater quantity of its *Tincture*. The Advantage of theſe Proceſſes is but ſmall, tho' the Trouble taken in making them is exceſſive. But 'tis enough to diſguſt them, if the Preparation be but plain and ſimple. However, that which we ſhall here prepare, is both eaſy, and no ways inferior to any of theirs. For the Texture

of the *Iron*, what by the Fire, and what by the Points of *Sal Armoniac*, whoſe Particles are very ſubtil and penetrating, becomes ſo divided and broken, as to impregnate the *Spirit of Wine* very ſufficiently. And we may venture to ſay, that *Sal Armoniac*, and the *Spirit of Wine*, come nearer to the Nature and Force of *Iron*, than any of the other *Menſtruums* we have before mentioned.

So that by this means, we do not only extract the Subſtance of *Iron*, but find a proper Vehicle, and as it were an Auxiliary for it. *Mynſicht* was the firſt Inventor of this *Tincture*, tho' he prepar'd it in a different manner. I will give you the whole Proceſs from the Author himſelf, becauſe 'tis worth mentioning.

℞ *Of Sal Armoniac two handfuls, of Steel one; mix 'em, and diſtil 'em gradually by Retort, firſt with a ſlow, then with a ſtronger Fire; ſo the Eſſence of Steel will remain at the bottom. Take this out, and edulcorate it very well, that it may be free from the ſharpneſs of the* Sal Armoniac, *then put this edulcorated Matter into a Cucurbit, and extract the Tincture with Spirit of Wine. When all the Tincture is extracted, take the Spirituous Tincture, and draw off about half with an* Alembic; *what is left, together with the extracted Eſſence, filtre thro' brown Paper, and preſerve it for Uſe, as the true Tincture of Steel.*

How very tedious and prolix this Operation is, you will eaſily perceive; one wou'd think it ought to afford us ſome mighty *Panacea*, to recom-

pence all the Pains one muſt be at; but there is great Reaſon to queſtion even this. For *Diſtillation* is not ſo capable of diſſolving *Iron*, as *Calcination* is; for in this, a fiercer Fire is made uſe of: Beſides, the *Ablution of Sal Armoniac* is altogether needleſs; for that *Salt* does both haſten the Extraction of the *Tincture*, and increaſe its Strength. Laſtly, *Abſtracting* the *Spirit* by the *Alembic*, is without any manner of Foundation. For the *Tincture*, during its *Abſtraction*, caſts off thoſe Particles, which are moſt volatile; and conſequently thoſe, which are moſt efficacious. But if we wou'd increaſe the Strength of the *Tincture* by this kind of *Extraction*, it wou'd be done much better, if by a longer *Digeſtion* it imbib'd the Corpuſcles of the *Iron* more plentifully.

The

The Seventh Lecture.

Of Extraction.

EXtraction, taken in its largeſt Senſe, ſignifies any Solution made by *Menſtruums*; unleſs we allow, as perhaps we very well may, this difference betwixt 'em, That in *Solution*, the *Menſtruums* abſorb the whole Subſtance of the Body; but in this, they only carry off certain Particles of it. And in this Senſe *Camphir* is diſſolv'd in *Spirit of Wine*. But *Jalap* is more properly ſaid to be *extracted*; for the *Roſin* only is diſſolv'd in the *Menſtruum*, the other Particles being left almoſt untouch'd. But the *Extraction* we ſhall now treat of, is ſuch an Inſpiſſation, or thickning of a Solution, as when you have drawn off a certain

Quantity of the *Menſtruum*, reduces the remaining Mixture to the Conſiſtence of Honey. So after the *Tincture of Safron* has been plentifully drawn off with *Spirit of Wine*, we afterwards abſtract the Spirit by Diſtillation, till it comes to half the Quantity, and then place what is left upon Sand, in an open Veſſel, to the end, that all the remaining Moiſture may evaporate. By this Contrivance, the Particles of the *Safron* are ſo broken, and divided by the Spirit, that they very eaſily mix with it, and produce a ſufficiently liquid Tincture. But there being ſcarce any Spirit left after Diſtillation, the remaining Matter muſt thicken a little of courſe; and when it is put into an open Veſſel, and the more ſubtil Parts are diſſipated by the force of the Fire, it will be reduced into a thicker Conſiſtence than it was before, and is call'd an

Extract.

Extract. Sometimes the *Juices* of Vegetables run of themſelves into *Extracts.* Extraction, done after this manner, does not require any long Diſcourſe to explain it; ſince whatever has been ſaid of Digeſtion, may be very well apply'd to it.

Extracts are chiefly made out of the Vegetable Kingdom, and require different *Menſtruums*, according to the different Nature of the Plants; as may be obſerv'd, eſpecially in *Extracts* from *Gums.* For ſuch as are *Mucilaginous*, as *Gum Arabic*, and *Tragacanth*, &c. are not ſo eaſily diſſolv'd but in *Aqueous* Liquors: On the other hand, *Reſinous Gums*, as *Galbanum*, *Scammony*, &c. muſt have *burning Spirits* to diſſolve them. There are others again of a middle Nature, which may be diſſolv'd in either ſort of *Menſtruums*, tho' not ſo eaſily in one as in the other. Thus *Aloes*

and

and *Rhubarb*, which are ſomething *Reſinous*, are better made into Extracts with *Spirit of Wine*, than *Water*. But Plants, which abound leſs with *Roſin*, ſuch as *Hellebore*, *Scorzonera*, &c. are more commodiouſly extracted with Water, than with *Spirit of Wine*. If we wou'd therefore perform *Extraction*, as it ſhou'd be, we ought to find out a proper *Menſtruum*, and one which is as it were a-kin to the Body to be extracted.

The Chymiſts have beſtow'd more pains upon the Extraction of *Opium*, than of any thing beſides, it being one of the moſt noble Medicines we have. And it is ſtill in diſpute among them, what is the moſt proper *Menſtruum* for it. 'Twou'd be a tedious buſineſs to relate all the Forms and Proceſſes they give us of this Operation, 'twill be enough juſt to touch upon one or two of 'em:

'em: Some therefore extract *Opium* by the help of *Acid Menſtruums*, after it has been evaporated, either upon *live Coals*, or *kindled Brimſtone*; for this Reaſon, if we may believe them, that the Narcotick ſtrength of the *Opium* may be fix'd and corrected; but this way of obtaining the Extract of *Opium* is all trifling, unleſs we would have a *Caput Mortuum* for an Extract, inſtead of Medicine. For the more ſubtil part of the *Opium*, that abounds moſt with *volatile Salt*, flys away upon the application of Fire or Heat. Further, it ſeems very Injudicious to make uſe of *Acids*; for if we examine the Virtue of *Opium*, we ſhall find, that *Acids* are quite contrary to it. *Acids* coagulate, and induce a Lentor into the Blood; whereas nothing in the world does more effectually attenuate it, than *Opium*. So that to join *Acids* with *Opium*,

for

for the intention of Curing, is juſt like a Surgeon's blunting the Edge of his Inſtrument, that he may make the better Inciſion. And for the ſame Reaſon the *Acid Juices* of Vegetables, with which *Opium* is wont to be fermented, will hardly eſcape Cenſure, when they come to be examin'd, how little ſoever they may diminiſh its Virtue. Others add Salt of *Tartar*, which they cry up ſo much, as to give it the Name of the *Corrector of Opium*; but as there is no great matter of Hurt in it, ſo no mighty Advantage is to be had from it. For *Opium* has no need of this Salt to facilitate its Extraction, ſince it diſſolves in a *Menſtruum* readily enough of it ſelf, nor is that Medicine, which aſſuages Pain ſo miraculouſly, of ſuch a ſavage and malignant Nature, as to ſtand in need of being tam'd and corrected in that manner. Without

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out doubt that *Correction*, us'd by the *Ancients*, however improperly so call'd, was much better, who always mix'd *Aromaticks* with their *Opiates*, by which the Force of the *Opium* was broke so little, that it rather acquir'd from 'em a new and greater Force, for Medicinal Uses. For this Reason *Sydenham*, in Imitation of the Ancients, puts *Safron*, *Cinnamon*, and *Cloves* in his *Laudanum*. The other *Menstruums*, made use of by Chymists to Extract *Opium*, are *Spirit of Wine*, *Wine* it self, and *Water*, and each of them has its Champions and Defenders. Tho' perhaps the Quarrel may be fairly ended, if we give the Preference to *Wine*. For, not to mention, that *Spirit of Wine* is too hot for some Constitutions, it too plentifully absorbs the *Resinous* part of the *Opium*: And so does often occasion Loathings and Gripes. Besides, all

hot

hot Spirits produce a *Coagulum* in the Blood, which is quite contrary to the Nature of *Opium*, as has been taken notice of already. On the other hand, tho' *Water* does extract *Opium* well enough, yet, by reaſon of its weakneſs, 'tis not very agreeable to the Stomach, eſpecially of one that is Sick. But *Wine*, eſpecially *Canary* and *Sherry*, have none of thoſe Faults; for they don't only very well extract the *Volatile Salt* of *Opium*, which contains the greateſt Virtue of the Remedy, but they are both very grateful to the Stomach, and ſerve as a Vehicle to convey the Medicine through all the Circulations of the Blood and Spirits.

One may obſerve, that when *Tinctures* are extracted by *Digeſtion*, they are very much ſaturated; but being afterwards drawn off by Diſtillation, they recover their ancient Colour.

Colour. For when the *Abſtraction*, by the Alembick, is perform'd with a ſtrong Fire, the Particles of the Liquors do ſo rarefy, that they very quickly aſcend, by reaſon of their Specifick lightneſs. Which you may obſerve, eſpecially in *Spirit of Wine*, there being no *Menſtruum* more apt to rarefy than that. But the minute Particle of Bodies, which ſwim in theſe Liquors, and tinge them with a certain Colour, how thin and ſubtil ſoever, being uncapable of Rarefaction, becauſe of their Solidity, are deſerted almoſt entirely by the Volatile *Menſtruum*, and can't be drawn off from the Cucurbit. But tho' they ſhou'd, by the Force and Aſſiſtance of Fire, attempt to raiſe themſelves, they can never aſcend to the top of the Alembick; but by the force of their Natural Gravity, muſt fall down again, and precipitate. In this manner

manner thoſe Liquors, which are *Abſtracted* from *Tinctures*, keep their proper Nature, and are ting'd with no *Colour*. But ſometimes the more light Corpuſcles, ſuch as thoſe of *Opium*, *Safron*, &c. riſe together with the *Menſtruum* into the Receiver, which may be perceiv'd both by Taſt and Smell, tho' they are not ſo numerous as to give a Tincture to the *Menſtruum*.

Thus *Extraction* is uſually perform'd; which Operation, tho' it may very properly be admitted among thoſe of *Chymiſtry*, yet, as to its uſe in *Phyſick*, may be a little call'd in queſtion. For almoſt all the more ſubtil Particles fly away, and are diſſipated, either when the *Menſtruum* is drawn off by Diſtillation, or when it evaporates in the open Air. So that if thoſe Particles are any ways uſeful in Medicine, 'tis to no purpoſe to ſeek for them

them in *Extracts*; but if we wou'd have only a Collection of the more groſs and unactive Parts, there is no other kind of Operation, which will ſo happily ſupply us with them. Finally, if we examine the Virtues of thoſe *Extracts*, which the *Chymiſts* ſo highly extol, we ſhall find them not ſo fit for *Medicines*, as for *Vehicles*, if one may ſo term 'em.

The Eighth Lecture.

Of Precipitaion.

Precipitation is that Proceſs in *Chymiſtry*, when Particles, after having floated, and been ſuſpended a-while in a *Menſtruum*, do at length ſink to the bottom. Theſe Particles precipitate ſometimes of their own accord, but oftner by the aſſiſtance of ſome other Liquor, drop'd into the *Menſtruum*. The Reaſon of the deſcent in both Caſes is the ſame. It wou'd be but to little purpoſe to enumerate all the Fictions and Hypotheſes, which have been thought upon, to account for *Precipitation*, eſpecially ſince this Operation is ſuch as may with leſs difficulty be reduc'd and ſolv'd by the Laws of Mechaniſm, than any other. You may clearly perceive, from

from what has been ſaid of *Digeſtion*, how Fluids may be made to ſuſtain Bodies ſpecifically heavier than themſelves; namely, By making the Reſiſtance, ariſing from the Coheſion of the Parts of the Fluid, equal to the Exceſs, which there is of Specifick Gravity, in thoſe Bodies above the *Menſtruum*. And we have ſhewn, that this Reſiſtance is proportional to the Surface of the Corpuſcles. Therefore a contrary Condition to this, is all that is requiſite, that they may be ſuſtain'd no longer; or, which is the ſame thing, that they may be *precipitated*; Namely, That the Tenacity of the *Menſtruum* be not proportional to the Gravity of the Corpuſcles. And this may be produc'd two ways.

In the *firſt place*, *Precipitation* generally follows upon dropping in a Liquor ſpecifically *lighter*. For by this Mixture, the Gravity of the

Menſtruum, which always is proportional to the compound Gravities of both Liquors, becomes lighter. The *Menſtruum* being thus diluted, the Force of Coheſion is alſo weakned, ſo that it is not able to reſiſt, or bear up the Bodies diſſolv'd in it; hereupon the *Æquilibrium* being taken off, they are precipitated by the Force of their Gravity. Juſt in the ſame manner as *Hydrometers*, which are eaſily ſuſtain'd in *Water*, if you pour in a good deal of any *burning Spirits*, ſink to the bottom of the Glaſs. And this does not only agree very exactly with the Laws of Mechanicks, but likewiſe with Experiments themſelves. Thus *Spirit of Sal Armoniac* does very plentifully precipitate the Filings of Metals, which are diſſolv'd in *Acid Menſtruums*, tho' it be abundantly lighter than any of them *. The

* *Tab.* 3.

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ſame thing is done quicker by *Spirit of Wine*, whoſe Gravity is known to be almoſt the leaſt of any *. By this *Spirit* alſo all *Salts*, which are ſuſpended in *Water*, are precipitated, and ſo unite into Cryſtals. So if you drop in *Diſtill'd Vinegar*, the *Droſs of Antimony* diffus'd in *Water* falls to the bottom, and affords you the *Golden Sulphur*. After the ſame manner *Water*, *Vinegar*, &c. makes a Precipitation from *Acids*, tho' more ſparingly. Nay, *Acids* themſelves being pour'd upon others, which are heavier, will precipitate whatever is ſwimming in them. Thus *Spirit of Salt* precipitates either *Lead*, *Copper*, or *Tin*, diſſolv'd in *Oil of Vitriol*. So little need is there for *Alkali*'s in this buſineſs, tho' all the *Chymiſts* have unanimouſly contended for them as abſolutely neceſſary.

* *Tab.* 3.

In the *ſecond place*, *Precipitation*

ſucceed as well, if you add a *heavier* Liquor to the *Menſtruum*. For the Particles of this Liquor, what with their Weight, and what with the Impetus they acquire in their Deſcent, carry down, and ſink all the Solid Corpuſcles they meet with in their way. So that the Corpuſcles being thus forc'd down, and kept there by this adventitious Liquor, cannot mount up into their former Situation. And if any one has a mind to try the Truth of this Reaſoning by Experiments, there are enow to confirm it: For not only *Acid Spirits*, but *Water* alone, will precipitate Tinctures of Vegetables extracted by *Spirit of Wine*. And the very ſame Tinctures, extracted with *Water* or *Wine*, are precipitated very copiouſly by *Acid Spirits*, which are heavier *. After this manner *Metals*, which are diſſolv'd in *Spirit of Sal Armoniac*, are precipi-

* *Tab.* 3.

cipitated with *Oil of Vitriol*, or *Spirit of Nitre*. The ſame Bodies, tho' ſuſpended in *Aqua Fortis*, are eaſily precipitated with *Oil of Vitriol*, or *Bezoartick Spirit of Nitre*. And this very Oil, if pour'd upon *Sal Volatile Oleoſum*, or any other Solution of *Salt*, never ſo much ſaturated, does not only ſink the ſmaller Particles, but converts almoſt the whole Liquor into *Salt*. For when theſe Liquors are pour'd upon one another, the *Salts*, with which they abound, being put into Motion by their Attractive Force, run mutually to embrace one another; and becauſe they don't recoil far back after the Congreſs, they are at length ſo united, as to become like a *Solid*, there being very little Phlegm remaining. The ſame may likewiſe be obſerv'd in *Tartarum Vitriolatum*. In making all theſe Experiments, there happens ſuch a

Conflict and Effervescence, as evaporates almost all the Moisture, with which the Salts are diluted. And upon this depends the *Rationale* of Chymical *Coagulation*, a thing of very great Consequence in the business of *Precipitation*. Nor can we account for *Oil of Tartar*'s precipitating Bodies dissolv'd in *Acids*, any otherwise, than from its making a kind of *Coagulum* with these Corpuscles, and thereby being too heavy for, and exceeding the Tenacity of the *Menstruum*.

Nor does *Coagulation* succeeed only upon the mixing of heavier Fluids, but it also very often promotes *Precipitation*, when the Gravity of the instill'd Liquor is intirely equal to that of the *Menstruum*, or but very little different from it. And this Agglutination of Parts is to be seen in many Liquors, but most of all in Saline ones. Thus *Spirit of*

Sal

Sal Armoniac, *Spirit of Harts Horn*, and *Human Blood*, *Sal Volatile Oleosum*, whose Gravities are nearly the same as that of common *Water*, precipitate the Solution of * *Sublimate* very plentifully, as you may observe in making the *White Precipitate of Mercury*. In which Experiment, the increase of the Weight gives a sufficient Indication of an Union of those *Salts*, which are pretty copious in the *Sublimate* and *Liquors*, which are pour'd upon it; for that which subsides at the bottom, exceeds in Weight the *Sublimate* which was at first put in. Likewise the *Magisteries* of Vegetables, extracted by *Precipitation*, do confirm this account of *Coagulation*; for these have a greater Specifick Gravity than the *Powders* of the Plants †. This additional Weight therefore, is to be imputed to the Particles of the *Liquor*, with which *Precipitation* is perform'd.

* *Tab.* 3.

* *Tab.* 2.

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The Ninth Lecture.

Of Cryſtallization.

Cryſtallization is ſuch a Combination of Saline Particles, as reſembles the form of a *Cryſtal* variouſly modify'd, according to the Nature and Texture of the Salts. In order to perform this Operation well, they take this Method; The Saline Body is diſſolv'd in Water, afterwards the Solution is filtred, which, after 'tis evaporated till a little thin Skin appears upon it, runs into Cryſtals. Diſſolution and Filtration are made uſe of, that the Salts may be purg'd from all Droſs; for otherwiſe, if any Extraneous Matter ſhou'd get in, not only the Tranſparency of the Cryſtals wou'd be impair'd, but the Figure alſo

alſo wou'd be mangl'd and broken.

Therefore theſe Salts being in this manner waſh'd and purg'd afreſh, the Water (as of no farther uſe) is taken off by Evaporation; which is done with deſign, that the remaining Solution ſhou'd be more ſaturated. And this Saturation of the Solution is neceſſary, that a greater quantity of the Salts might run into Cryſtals. Now theſe being nothing elſe but a Congeries of the Saline Particles, if the Cauſe of this Union is ſhewn, you will eaſily perceive, why they cannot ſubſide, in a more diluted *Menſtruum*. This Compoſition therefore ariſes from that *attractive* Force, by which Salts, which are near one another, do naturally ſtrive to coaleſce and unite: Which they do ſo much the eaſier, the nearer they are one another. For the Force of *Attraction* exerting it ſelf moſt at the point of Contact,

is

is the Cauſe of its being little or nothing, when Bodies are remov'd at a farther diſtance. Hence Salts, very much diluted with cold Water, ſcarcely *attract* at all, becauſe they are kept at too great a diſtance one from another, and hereupon remain quiet in their reſpective Quarters; and tho' the Solution ſhou'd be ſtronger, it wou'd part with its *Salts* but very ſparingly, without *Evaporation*; but by letting the Water be evaporated to a thin Skin, the Salts aré plac'd ſo near, as almoſt to touch one another; and conſequently they will attract one another very ſtrongly; and being very cloſely and intimately united, they are form'd as it were into ſo many little Bundles.

If any Saline Solution were to be let alone for ſome time, the *Cryſtals* wou'd precipitate, and fall of their own accord. For the Water,

which

which obſtructs the Coheſion of the Salts, does exhale; as ſeveral things, which you have obſerv'd in the Courſe of this Operation, do ſufficiently demonſtrate. But the very ſame Salts, being diſſolv'd in warm Water, do quickly and eaſily melt and ſwim in it; nor do they run into Cryſtals, ſo long as that retains its Heat. For the Motion, excited by the Heat, hinders and deſtroys the Motion ariſing from the *Attractive* Force. But as ſoon as the Water turns cold, and the Parts of it are at reſt, the Salts now being able to ſtand nearer to one another, exert their *Attractive* Force, and ſo unite themſelves into Cryſtals.

Salts of any kind may be reduc'd into Cryſtals, be they *Fixt* or *Volatile*. Of the *Fixt* the *Alkalizate* are indeed reduc'd with more difficulty. *Volatile Salts* muſt be fixt, before they can be reduc'd into Cryſtals;

Cryſtals; otherwiſe upon Evaporation they fly off, and are diſſipated. And even *Metals*, corroded with Saline Spirits, eaſily run into Cryſtals. This being matter of Fact, has given occaſion to the Curious to enquire, whether there be really any true *Salts* of *Metals*. And the Argument taken from theſe Cryſtals, has perſuaded many, that there are *Salts* contain'd in *Metals*; tho' it ſeems to be but a very weak one. For thoſe, which are call'd the *Salts* of Tin and Lead, are only the Corpuſcles, or ſmalleſt Particles of the *Metals*, ſo intimately united and cohering to the Corpuſcles of the *Saline Menſtruum*, as to be capable both of running into Cryſtals, and of being diſſolv'd and ſuſtain'd in Water, by means of the *Salts* they are entangl'd with: For if thoſe very *Salts* are put into a Calcining Fire, they revive into the

the *Metal* it ſelf. Nor is the Exiſtence of *Salt* in *Metals*, prov'd any better from *Vitriolum Martis*, or *Salt of Steel*, prepar'd with *Filings of Steel*, and *Oil of Vitriol*; in which, we grant, there is a little Portion of *Iron* contain'd; but ſince it has nothing but what is common with the Cryſtals of *Vitriol* it ſelf, it is very ill Reaſoning, from thence to conclude, that there is a Salt contain'd in the *Iron*. For we might better infer, from the apparent affinity there is between them, that ſome few Particles of *Iron* ſtick to the native *Vitriol*; which indeed is plain enough by Experiments. For the *Calx* of *Vitriol* is found to Attract a Magnet. And for this Reaſon, they who make Artificial *Vitriol*, mix with it a great quantity of *Iron*. So little is this Notion of *Metalline Salts* favour'd by the Reaſons which are drawn from *Cryſtals*.

ſtals. There are ſome that pretend they can extract a *Salt* from *Metals*, without the aſſiſtance of a *Saline Menſtruum*, or Fire. So *Borrichius* affirms, that he extracted a Cryſtalline Salt from Metals, beaten only with *Mercury* and *Water*: But we have only the Author's Word for it. For this Opinion has been Exploded, and not without good Reaſon, by the beſt of Chymiſts. The ſame may be ſaid of the Salts of *Pearls*, and *Corals*, &c.

Hitherto we have explain'd the Reaſon of Cryſtals; as for the Figures of them, you ſee your ſelves what they are; the Beauty and Variety of which is ſo admirable, that there is ſcarce any thing in Nature, which can entertain the Eye more agreeably. The Figures of theſe are ſometimes ſeen by the naked Eye, but by the help of *Microſcopes*, are diſcern'd much better. In *Common Salt* we plainly

plainly discover *Quadrilateral Pyramids* with Square Bases. In *Sugar*, the same *Pyramids* with Oblong and Rectangular Bases. In *Alum*, they rise with Six Sides, supported with an Hexagonal Base. The Crystals of *Vitriols* very much resemble Icicles, united one to another with great variety, among which lie some Polygons, as may be discover'd with the naked Eye. *Sal Armoniac* very elegantly imitates the Branches of a Tree, and *Harts Horn* looks like a Quiver of Arrows. *Glauber*'s *Sal Mirabilis*, which is made of *Common Salt* and *Vitriol*, exhibits the Figure of both Salts. *Nitre* appears in certain Prismatical Columns, not much unlike Bundles of Sticks, among which there are interspers'd some Rhomboidal, and some Pentagons, which seem to come very near those of *Common Salt*. Hence *Lemery*

very juſtly remark'd, that *Nitre* cou'd not be purify'd by any Art or Contrivance whatever, but ſomething of a *Sal Gem*, or *Foſſil Salt*, wou'd ſtick to it. But *Salt of Tin* outdoes all for Beauty, in which are Lines like little Needles, which ſpread themſelves every where from a Point, as from a Centre, ſo as to repreſent a Star, much like what we ſee in the *Regulus of Mars*.

But this is very peculiar in theſe Salts, that let them be never ſo divided, and reduc'd into minute Particles, yet when they are form'd into Cryſtals, they each of them reaſſume their proper Shape: So that one might as eaſily diveſt and deprive them of their Saltneſs, as of their Figure. This being an immutable and perpetual Law, by knowing the Figure of the Cryſtals, we may underſtand what the Tex-

ture

ture of the Particles ought to be, which can form thoſe Cryſtals. And on the other hand, by knowing the Texture of the Particles, we may determine the Figures of the Cryſtals. For ſince the Figures of the moſt ſimple Parts, remain always the ſame, 'tis evident the Figures, which they run into, when compounded and united, muſt be uniform and conſtant. And ſince the Force of Attraction is ſtronger in one Side of the ſame Particle than another, there will conſtantly be a greater Concretion of Salts upon thoſe Sides, which attract more ſtrongly. From hence it may eaſily be demonſtrated, that the Figure of the leaſt Particles, is entirely different from that which appears in the *Cryſtal*. But we muſt leave this to the *Mathematicians*, leſt we ſhou'd ſeem to encroach upon their Province.

If I have explain'd this Subject, ſo as to make it underſtood, I have my Aim. For I thought that theſe Operations of *Chymiſtry* might be better illuſtrated by a Plain and Simple Explication, than with all that Pomp and medley of Things, which *Chymiſts* ſo much abound with. Nor do I imagine, you expect to be made *Adepts*, but rather deſire to underſtand the Reaſon of Chymical Operations, and to learn of what uſe theſe Inquiries may be to you. And that you may attain this, no other Principles will better ſerve your purpoſe, than what we have here made uſe of, which are found, not only to be moſt agreeable to Nature, but the moſt plain and eaſy to apprehend. In theſe you find ſuch a thorough Agreement and Connexion, that if they were not really true, you your ſelves muſt confeſs, they could never

never be ſo conſiſtent with one another. There remain indeed many other things, which cannot be accounted for, without great difficulty: but we hope the difficulty, ſometime or another, may be ſurmounted, when People will take the pains to purſue theſe Inquiries in a right Method. 'Tis poſſible there may be ſome things, which the greateſt Genius and Induſtry cannot dive into; but if theſe can't be reduc'd to the Laws of Mechaniſm, we had better confeſs, that they are out of our reach, than advance Notions and Speculations about 'em, which no ways agree with ſound Philoſophy. Therefore, as I have ſaid nothing upon this Subject to you, but what I preſume to be true, ſo I have choſen to paſs over the Miſtakes and wrong Reaſonings of others. 'Tis enough for me to

have made good my own Opinion; to ſpend much pains in confuting others, would be a Task, not only troubleſome to you, but very unneceſſary for me.

The

The First TABLE.

In which the Rarefaction, Ebullition and Aſcent of Liquids is eſtimated.

The following Liquids were compared one with another in the ſame degree of Heat, and in Matraſſes of the ſame magnitude.

	Rarefaction.	
	Degrees.	*Time.*
	Inch.	
Spirit of Wine	$\frac{1}{2}$	
Oil of Turpentine	$6\frac{1}{2}$	20 M.
Common Water	$\frac{3}{4}$	

NB. Spirit of Wine and Oil of Turpentine roſe $\frac{1}{4}$ Inch in a Minute, but Water did not begin to riſe 'till after Six Minutes.

	Inch.	
Oil of Turnips	1	
Diſtill'd Vinegar	$\frac{1}{2}$	12 M.
Common Water	$\frac{1}{4}$	
Simple Aqua Fortis	4	
Oil of Vitriol	4	15
Spirit of Nitre, Bezoart and Herm. ana	$3\frac{3}{4}$	
Simple Aqua Fortis	3	12
Common Water	$1\frac{1}{2}$	
Simple Aqua Fortis	2	
Spirit of Nitre, Bezoart and Herm. ana	2	8

	Rarefaction.	
	Degrees.	*Time.*
	Inch.	
Simple Aqua Fortis	1½	
Spirit of Wine	3	7 M.
Spirit of Sal Armoniac	½	
Luke-warm Urin	3	
Common Water	2	
Spirit of Sal Armoniac	2¼	18
Cold Urin	2¼	
Common Water	¾	15
Distill'd Rue Water	2½	
Common Water	2	30
Oil of Vitriol	3	
Aqua Fortis	2	27
Spirit of Vitriol	1	
Common Water	½	

The Time of Ebullition.

Spirit of Wine	9 M.
Oil of Turpentine	15
Common Water	29
Oil of Turnips	4
Distill'd Vinegar	6
Common Water	8
Simple Aqua Fortis	6
Spirit of Salt	6
Spirit of Nitre Herm.	9
Simple Aqua Fortis	9
Common Water	15
Spirit of Nitre, Bezoart & Herm.	5
Common Water	7
Small Beer	30
Milk	32
Common Water	35
Oil of Vitriol	60 the Fire incr.
White Wine Vinegar	18 M.
Alegar	25
Red Wine	30

Oil of Vitriol boil'd not till after an Hour.

At 2 a Clock 13 M. In a moderate heat and Matraſſes of equal bigneſs, the length of their Necks being 13 In. & the Diam. ¼ In.

Simp. Aqua Fort.	1 m. ¼	I. 3 H. 16 m. 7 I.
Oil of Turpent.	1 m. ½	Inch
Small Beer	9	began to ariſe.
Milk	5	
Common Water	16	3 h. 33 m. 4 Inch.
Spirit of Vitriol	3	

Beer	3 H.	They boild to that degree as to run over out of the Matraſs. Milk and Beer do not only riſe with bubbles, but with a vaſt froth.
Milk	3 H. 12 M.	
Oil of Turp.	3 H. 16 M.	

At 2 a Clock, 13 M. In a ſtronger Fire.

Oil of Turnips		They aroſe in one Minute, but the Oil of Turnip four times higher than the reſt.
Red Wine		
Vin. of Wine & Beer		
Spir. Sal Arm. Succ.		

		In.	25 m. In.	
Oil of Turnip	8 m.	5	—	It boil'd over the Matraſs.
Sp. Sal Arm.		1	2	
Vin. of Beer		1½	3¼	It boil'd over the Matraſs 60 m.
—— of Wine		1	4	37 m.
Red Wine		½	3½	35 m.

To theſe Experiments it will not be amiſs to annex thoſe which are made by Diſtillation. In which we have made uſe of the ſame Degree of Heat, and of the ſame Matraſſes.

		The time of Aſcent.	*The Quantity Diſtill'd.*
Common Water	Ana ℥ 4.	in two Hours	℥ 4
Oil of Turnips			℥ 1 ſcarce
Simple Aqua Fortis	Ana p. æq.	they came off in the ſame time.	
Common Water			
Common Water	Ana p. æq.	in two Hours	℥ 2
Oil of Turpentine			℥ 1
Oil of Turnips			℥ 1

Double

		The time of Aſcent.	The Quantity Diſtill'd.
Double Aqua Fortis	Ana p. æq. in 2 Hours		℥ 1
Unrectify'd Spirit of Harts-Horn			℥ 3
Spirit of Vitriol			℥ 1
Common Water			℥ 2
In a ſtronger Fire. Oil of Vitriol	Ana p. æq.	in 3 H.	℥ 1 in five
Sp. Nitre Bez.		9 m.	℥ 5 Hours.
Com. Water		9 m.	
Spir. of Wine		7 m.	℥ 7 in three
Solu. Camph. in wh. Wine		9 m.	Hours. There was more Camphire than Wine aſcended.

The Second TABLE.

In which the Specifick Gravity of Solids is eſtimated.

	The Weight.		*Diminution*	*Proport.*
	In Air.	*In Water.*	*of Weight.*	*Gravity.*
OF Crude Mercury	gr. 60.	gr. 55¾	gr. 4¼	14
Lead		54¼	5¾	11⅖
Copper		53	7	8½
Braſs		id.		
Crude Tin		id.		
Regulus of Antimon.		52	8	7½
Reg. of Steel & Cop.		id.		
Block Tin		id.		
Iron		51⅙	8⅙	7 alm.
Cinnabar of Antimon.		51	9	6⅘
Litharge of Silver		id.		
Gold		50½	9½	6
Silver Six-Pence		49	11	5 5/11
Calcin'd Copper		id.		

Glaſs

	The Weight.		*Diminution of Weight*	*Proport. Gravity.*
	In Air.	*In Water.*		
Of Glaſs of Antimon.	gr. 60	gr. 48	12	5
Lapis Calamin.		id.		
Tutty		47	13	$4\frac{8}{13}$
Crocus Metallorum		$46\frac{1}{2}$	$13\frac{1}{2}$	$4\frac{1}{2}$
Crude Antimon.		45	15	4
Steel prep. with Sulph.		41	19	$3\frac{3}{19}$
White Lead		id.		
Green Glaſs		39	21	$2\frac{18}{21}$
Red Corall		id.		
Flint		38	22	$2\frac{2}{11}$
Bole Armon.		id.		
Lapis Judaicus		$38\frac{1}{9}$	$21\frac{8}{9}$	$2\frac{1}{2}$
Flint-Glaſs		id.		
Bone of Sheep juſt kill.		33	27	$2\frac{6}{27}$
Filings of Steel		30	30	2
Terra Lemnia		id.		
Ivory		29	31	$1\frac{29}{31}$
Harts-Horn		28	32	$1\frac{7}{8}$
Mineral Sulphur		id.		
Crude Tartar		27	33	$1\frac{27}{33}$
Venice Glaſs		$26\frac{1}{2}$	$33\frac{1}{2}$	$1\frac{53}{67}$
Ruſt of Braſs		25	35	$1\frac{5}{7}$
Burnt Lead		24	36	$1\frac{6}{9}$
Gum Arabic		18	42	$1\frac{9}{21}$
Opium		16	44	$1\frac{4}{11}$
Lignum Guaiacum		15	45	$1\frac{1}{3}$
Gum Tragacanth		id.		
Myrrh		12	48	$1\frac{1}{4}$
Cortex Guaiaci		id.		
Gum Guaiacum		11	49	$1\frac{11}{49}$
Roſin of Scammony		10	50	$1\frac{1}{5}$
Lignum Nephr.		id.		
Iſinglaſs		6	54	$1\frac{1}{9}$
China-Root		4	56	$1\frac{1}{14}$
Frankincenſe		id.		
Gall		2	58	$1\frac{1}{29}$
Gentian	leſs	15		$\frac{60}{75}$
Peruvian Bark	leſs	$16\frac{1}{2}$		$\frac{120}{153}$
Oak	leſs	26		$\frac{60}{86}$
Firr	leſs	48		$\frac{60}{108}$

The Weight of Salts in Spirit of Wine were found to be as follows.

	The Weight.		*Abatements of the Wei.*	*Proport.*
	In Air.	*In Sp. Wine.*		
Of Crude Mercury —	gr. 60.	gr. 57 1/3	gr. 2 1/3	17 near
Mercurius Dulcis ——		56	4	15
Panacea Rubr. ——		55	5	12
Merc. dul. 3d time ſub.		id.		
—— 4th time ſub.		54	6	10
Turpith Mineral ——		id.		
Corroſive Sublimat. —		52 1/4	7 1/3	8alm
Sugar of Lead ——		42	18	3 6/18
Fixt Salt of Nitre —		id.		
Magiſtery of Corall —		39	21	2 1/21
Sympathetick Powder -		id.		
Tartar Vitrioliz'd ——		38 1/2	21 1/2	2 3/43
Glauber's Sal Mirabili		38	22	2 8/44
Emetic Tartar ——		37	22 1/2	
Sal Guaici —— ——		37	23	2 1/23
—— Prunella ——		id.		
—— Polychreſtan —		id.		
—— Enixum ——		id.		
Cream of Tartar ——		34	26	2 4/13
White Vitriol ——		id.		
Salt of Steel ——		33	27	2 6/27
Green Vitriol ——		32		
Red Chalcanthuon —		id.		
Salt of White Vitriol --		id.		
Nitre —— ——		id.		
Volat. Salts of Harts H.		27	33	1 2/33
Ens Martis once ſubl. -		26	34	1 1/17
Sal Armoniac purify'd -		id.		
Ens Mar. 3d time ſubl.		22	38	1 1/19

The

The Third TABLE.

In which the Specifick Gravity of Liquids is eſtimated.

The Weight of a Piece of Lead in Air, Gr. 455.

	Weight.	*Diminut. of Weight*	*Propor.*
IN Oil of Vitriol —	gr. 379	gr. 76	$5\frac{75}{76}$
Hermetic Sp. Nitr.	383	72	$6\frac{23}{72}$
Sp. Nit. with Oil Vit. -	396	59	$7\frac{49}{59}$
Of common Nitre —	397	58	$7\frac{39}{58}$
— Nitre Bezoartic —	id.		
Double Aqua Fortis —	400	55	$8\frac{1}{5}$
Spirit of Vitriol ——	406	49	$9\frac{16}{49}$
Spir. Salt with Oil Vit.	408	47	$9\frac{37}{47}$
Solu. of comm. Salt ʒ 2 with ʒ 6 of com. Water	id.		
Sp. of Sal Armo. Succ.	409	46	$9\frac{41}{46}$
—— with Pot-Aſhes	id.		
Simple Aqua Fortis —	410	45	$10\frac{1}{9}$
Solution of Sal Enix ʒ 1 in Water ʒ 5	id.		
A Decoct. of Gentian -	$410\frac{1}{2}$	$44\frac{1}{2}$	$10\frac{20}{89}$
Spirit of Tartar ——	411	44	$10\frac{11}{44}$
A Dec. of Snakeweed -	id.		
Sp. of Harts H. not rect	id.		
A Dec. of Salſa parilla	412	43	$10\frac{25}{43}$
—— of China Root	id.		
Spirit of common Salt	$412\frac{1}{2}$	$42\frac{1}{2}$	$10\frac{1}{7}$
A Decoct. of Arum —	id.		
A Solution of Alum ʒ 1 ʒ 1 in Wat. ʒ 6.	413	42	$10\frac{1}{6}$
Syden. Liqu. Laudan. -	id.		
Liq. Panacea of Op. —	id.		
Dec. of the Peru. Bark -	id.		
—— of Pomegranuts -	id.		

The ſame Piece of Lead

In

		Weight.	*Diminut. of Weight*	*Proport.*
The same Piece of Lead	In a Solut. of Sal Arm. pur. ʒ 1 & wh. Vit. ʒ 1. in Water ʒ v.	gr. id.		
	Urine	413½	41½	10 8/8 0/3
	Sweet Spirit of Nitre	414	41	11 4/2
	Common Water	id.		
	A Tinct. Alo. with Wat.	id.		
	A Dec. of red Sanders	id.		
	Distill'd Vinegar	414¼	40¾	
	Mint, Rue, Savin — Water Distil.	415	40	11½
	Vinegar	415¼	39¾	
	Milk	415½	39½	
	A Decoction of Savin	id.		
	An Inf. of Harehound	416	39	11 2/3 6/9
	of Mint	id.		
	of Wormwood	id.		
	Elix. pro. wit. Sal Vol.	416½	38½	
	An Infusion of Tea	id.		
	Spirit of Saffron	417	38	11 3/3 7/8
	Spir. of Sal Armoniac with quick Lime	418½	36½	
	Sweet Spirit of Salt	id.		
	Tincture of Castor	419	36	12 2/12
	Sp. Wine with Camph.	id.		
	Mynsicht's Tinct. Steel	420	35	13
	Tinct. Sulph. with Spirit of Turpentine	id.		
	Oil of Turnips	id.		
	Tincture of Corall	421	34	13 3/3 3/4
	Spirit of Wine	421½	33½	13 3/6 9/7
	Oil of Turpentine	422½	32½	
	Sp. of Wine rectify'd	423	32	14 7/3 2/2
	Boil'd Water	424	31	14 2/3 1/1

The Numbers in the last Column show the Proportion of the Specifick Gravity of Fluids, if compar'd reciprocally. For as $11\frac{3}{8}$ is to $5\frac{5}{6}$, so is the Gravity of *Oil of Vitriol* to the Gravity of *Spirit of Safron*, viz. about double.

A N

APPENDIX,

CONTAINING

The Account given of these

LECTURES

IN THE

Lipsick Transactions;

With some Remarks upon it.

By the Author.

The Second Edition.

LONDON:
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MDCCXXIX.

PRÆLECTIONES CHYMICÆ, *in quibus omnes fere Operationes Chymicæ ad vera principia & ipsius Naturæ leges rediguntur*, Oxonii *habitæ*,

A JOHANNE FREIND, *M. D. Ædis Christi Alumno.*

Amstelodami, apud Janssonio Waesbergios, 1710, 8. *constat. plag.* 7.

CHYMICOS in experimentis cum laude hactenus progressos esse agnoscit Autor, in iis autem explicandis parum profeciisse affirmat, talibus quippe usos principiis, quæ vix intelligi possint. Artem igitur Chymicam illustraturus singulas operationes eo, quo inter se connexæ sunt,

ordine explicare & qua potiſſimum vi Mechanica edantur, diſquirere intendit. Monet autem viam, qua ad Mechanica principia Chymia exigi poſſit, primum aperuiſſe Johannem Keil in iis, quæ ex Tranſactionibus Anglicanis Sectioni Sextæ Tom. IV. Supplementorum p. 272. & ſeqq. inſervimus, & ſpem facit operis Phyſici ab ipſo edendi, in quo res maxime reconditas illuſtratum iri ait. Adhibet nimirum præter notiſſima principia Arithmetica, Geometrica & Hydroſtatica, etiam hypotheſin Keilianam (quam loco citato ipſis Autoris verbis deſcripſimus, & jam in Actis Anni ſuperioris attigimus) de vi attractice particularum minimarum. Verum enim vero Dn. Keilius cum ſequacibus redit reapſe ad qualitates occultas, quales apud Scholæ Philoſophos ſympathia & antipathia fuere, dum vim quandam attractricem ſtatuit, quæ ſi (ut ipſe vult) primitiva

eſt,

eſt, omnique materiæ erga omnem materiam eſſentialiter competit, utique per rationes mechanicas explicari nequit: atque adeo vel erit aliquid abſurdum, vel in miraculum ſeu voluntatem Dei extraordinariam reſolvetur, ad quam tamen in Phyſicis ſine neceſſitate confugiendum non eſſe, convenit inter intelligentes. Quodſi aliter procedimus & fictionibus indulgemus, reditur ad Philoſophiam quandam phantaſticam Scholæ vel etiam Enthuſiaſticam, qualis Fluddi fuit. Ita uno ictu ſubvertentur, quæ in Anglia ipſe Robertus Boylius & alii Virii docti de rebus naturalibus mechanice, id eſt, rationabiliter explicandis magno ſtudio ſtabiliverunt, quæ Boylius etiam diſerte ad Chymica applicuit. Juxta infelicem hanc philoſophandi rationem Autor adeo ſupponit, omnes materiæ partes a ſe invicem trahi; vim attractivam per exigua admodum ſpatiola diffundi & in contactu

validiſſimam exiſtere, decreſcere autem in ratione majore, quam eſt duplicata diſtantiarum ; eandem pro varia particularum figura & denſitate diverſam eſſe ; immo in uno latere fortiorem ſeſe exerere quam in alio ; particulas eo majore velocitate ad ſe invicem accedere, quo ſint minores ; cohæſionem denique materiæ in corporibus ab hac attractione oriri, & pro varia contactuum quantitate multifariam mutari. Sed hæc omnia ſine qualitate illa occulta attractice, veræ philoſophiæ principia confundente & in antiquum chaos reducente, commode explicare poſſunt, partim etiam a Viris doctis jam explicata ſunt, ſtatuendo plurimas materiæ particulas ſphæra quadam magnetica fluidi ſubtilioris eſſe circumdatas, cujus motu (ut in magnetibus noſtris fieri videmus) attrahant ſe invicem aut repellant & ad ſitum convenientem diſponant, quoties ſcilicet libertatem aliquam

aliquam ſunt nacta. Ut alios multos modos mechanicos taceamus a Pulſu ortos, quibus ſine attractione proprie dicta explicari poteſt, cur corpora ad ſe invicem accedant, ut attrahi videantur ; veluti cum aqua per ſuctionem in tubos aſſurgit, vel cum guttæ binæ ejuſdem liquoris ex contactu ſubito in unam coaleſcunt. Itaque ad aliquid precarium & minime intelligibile confugere neceſſe non eſt. Et talibus ſemel admiſſis apertaque fingendi licentia, mox erunt qui alias hujuſmodi qualitates occultas, ſeu quas ipſi agnoſcant abſolute inexplicabiles, comminiſcentur, & paulatim ad veterea ignorantiæ aſyla redibunt. Si detur vis attrahendi ſeu ſympathia, quidni pari jure detur vis repellendi ſeu antipathia. Ita facile etiam dabitur Antiperiſtaſis, dabuntur qualitates emiſſe per modum ſpecierum cum ſuis actu potentialibus ; dabitur funiculus Lini

attractivus a Boylio refutatus; dabitur in materia eadem variatio extensionis non apparentis tantum, sed etiam veræ, ejusdemque materiæ accurata in majus volumen distensio, aut in minus volumen compressio, sine aliena materia intro admissa vel expulsa, seu rarefactio aut condensatio proprie dicta, tanquam mater vis elasticæ: imo hanc extensionis variationem, ni fallor Ds. Keilius jam ipse introducere conatur loco supra laudato. Et ut verbo dicam, pleraque omnia monstra Scholastica, studio Baconi, Galilæi, Jungii, Cartesii, Hobbii, Toricelli, Pascalii, Boylii profligata velut agmine facto per posticum iterum in Philosophiam, nisi cavemus, irrumpent. Videamus vero, quomodo Autor figmento isto ad Chymicas operationes explicandas utatur.

Cum Chymica sit Ars corporum naturalium partes vel segregatas conjungendi, vel conjunctas segregandi, idque

idque plerumque ignis auxilio; eam in Diacriſin & Syncriſin dividit. Ad illam calcinationem, diſtillationem, ſublimationem, ad hanc fermentationem, digeſtionem, extractionem, præcipitationem, & chryſtallizationem refert. Calcinatio quoniam ſine liquatione nunquam fere contingit, hanc primo loco explicat.

Cohærent ex mente Autoris particulæ per mutuam attractionem, in ipſo contactu fortiſſimam. Liquantur ergo corpora, dum corpuſcula ignea in ea ſe inſinuant & ita ſegregant, ut particularum multo minor contactus fiat. Hanc ſegregationem a corporum liquefactorum rarefactione probat, & ex cohærentiæ diſcrepantia omnem in corporibus liquandis varietatem deducit. Calcinationem diuturnioris liquationis effectum pronuntiat, dum corpuſcula magis ſubtilia avolent, & igneæ particulæ ea multitudine in corpus ſe inſinuent, eique quaqua-

verſum ſe immiſceant ac intimius agglutinent, ut amplius perſiſtere nequeat fluiditas: id quod ex aucto corporum calcinatorum pondere probat. Ad calcinationem quoque vitrificationem revocat, & ſine ratione decrepitationem atque detonationem apud Chymicos ab ea diſtingui, notat. Aſcenſum fluidi in diſtillatione duplici cauſæ adſcribit, ſpecificæ nempe levitati & impulſui. Demonſtrat itaque particulas rarefactas ſpecifice leviores fieri, e. gr. moleculam aquæ, cujus gravitas eſt ad gravitatem aeris, ut 800 ad 1, ſi ejus diameter per rarefactionem decupla evadat. Sed leviora in gravioribus aſcendunt. Erit autem tanto promptior aſcenſus, quo corporum particulæ facilius rareſcunt. Impulſum a celeritate deducit, qua ignea corpuſcula moventur, virium quantitatem ex facto maſſæ in celeritatem per communem errorem paſſim in his Actis notatum æſtimans. Ad

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elevationem particularum ſpecificè graviorum multum conferre ſuperficiem eorundem, cum plura ignes corpuſcula in eas impetum faciant, ſi lata fuerit, quam ſi exigua exiſtat. In elevatione ſolidorum, quæ fit per ſublimationem, rareſcentiam vix locum habere, ſed ſoli impulſui aſcenſum tribui debere. Conſiderandum vero eſſe, quod in particularum ſejunctione vi ignis facta gravitas minuatur in ratione cuborum, ſuperficiem in ratione quadratorum diametrorum, atque adeo abolita fere gravitate lata ſatis ſuperficies particulæ evehendæ relinquatur. Ex. gr. ſit diameter corporis 12, gravitas 12. Si diameter evaſerit ſubdupla, gravitas infra binarium ſubſiſtit, ſuperficies autem ad 36 aſſurgit. Fermentationem per motum partium inteſtinorum definit, qui ſuboritur, ſi ſalia in liquoribus ſeu menſtruis colliqueſcunt, eamque in diſſolutionem & ebullitionem

nem dividit. Diſſolutionem fieri, ſi ſalia diſſolvenda validius attrahant particulas fluidi, quam hæ a ſe invicem trahantur. Ita autem fieri, ut in viciniam ſalium proprius ire contendant, ſicque in motum concitatæ cum quodam impetu in ſalia ferantur & in earum meatus aditu parato eadem comminuant atque diffringant. Quodſi particulæ ad motum concitatæ elaſticæ fuerint, fermentationem oriri, cum eadem celeritate poſt ictum recedant, qua prius ad ſe invicem accedebant. Aerem rarefactum, dum expellitur, ebullitionem cauſari, & motu vehementius increſcente, calorem excitari. Amalgamationem & corroſionem eodem modo explicat: nec aliter de digeſtione ſtatuit, niſi quod hic ignis in ſubſidium vocetur. Extractionem quoque per eandem particularum attractionem declarat: præcipitationem vero fieri ait, vel ſi liquor ſpecifice levior inſtillatus menſtrui gravitatem

tatem & conſequenter tenacitem minuat, ut particulæ ſpecifice graviores, quæ huic ſeparandæ antea pares non exiſtebant, nunc eam vincant, ſicque deſcendant; vel ſi liquoris ſpecifice gravioris, dum infunditur, particulæ fundum petentes reliquas per fluidum diffuſas ſecum una abripiant: fundo non amplius elevandæ, cum per ſe fluido ſpecifice graviores exiſtant.

Chryſtallizationem denique a vi particularum ſalinarum attractiva immediate ac unice derivat. Similes meditationes paſſim habent recentiores Philoſophi, quando res chymicas ad cauſas revocare conantur, niſi quod a vi illa attractiva merito abſtineant, ne vocula eleganter ſonante ignorantiam ſuam palliare videantur. Sed tum demum eos valde profeciſſe dicendum erit, cum effecerint, ut experimenta nondum capta ex conſtitutis principiis prædici poſſint.

REMARKS

REMARKS *upon the foregoing Account.*

WHEN I firſt publiſh'd theſe Chymical Lectures, I was apprehenſive I might incur the Diſpleaſure of the Chymiſts, for preſuming to bring a little plain Senſe into an Art, which the Profeſſors of it wou'd never yet ſuffer to appear in any other Dreſs, than that of Fable and Jargon: But I thought my ſelf ſecure of not offending any Inquirer after Truth, who wou'd, I imagin'd, be pleas'd to ſee ſomething new in this part of Philoſophy, and the Science it ſelf reduc'd to the Laws of Nature; which are undoubtedly the true and only Principles, by which an Inquiry of this kind can proceed with ſucceſs, and which

which have never yet been apply'd to this Subject.

But the Reader will find, by the Account here annex'd, that it has happen'd quite otherwise: The Publishers of the *Lipsick Transactions*, without making any Objection to the Experiments themselves, or shewing any false Reasonings in the manner of Explaining them, attack some of the Principles, upon which the Explication is founded; and this they do, before they give any account of the Treatise it self, with a design to raise a Prejudice against it: A method surely very new, and very unfair in these Retailers of Learning, who pretend only to give a naked and impartial Relation of what is contain'd in Books, and to leave the Readers at liberty to judge for themselves. The Grounds upon which I proceeded in my Theory of Chymistry,

were

were the Principles and Method of Reaſoning, introduc'd by the Incomparable Sir *Iſaac Newton*; whoſe Concluſions in Philoſophy are as Demonſtrative, as his Diſcoveries are Surprizing. And ſince the *Editors* ſeem to have no true Notion of his Method, which is the only one by which Natural Knowledge can be advanc'd, I will here endeavour to explain it to them: I ſhall ſhew, that 'tis to this we owe the late great Improvements in Philoſophy; That the Objections they produce againſt it, ariſe from their wrong Apprehenſions of it; That the ſame Objections are of much more force againſt their own Principles, than thoſe of Sir *I. Newton*: And if from what I have to offer upon theſe Points, the Reader be convinc'd, that the Principles upon which my Lectures are founded, are ſufficiently juſtify'd and confirm'd;

I hope

I hope he will the eaſier be inclin'd to believe, that they are rightly apply'd; which the *Editors*, by their Silence in this Point, ſeem to confeſs.

It has been the conſtant Method of the *Carteſians*, and of thoſe too, for the moſt part, who call themſelves *Mechanical Philoſophers*, to aſſume an Hypotheſis or Figment, which has no Foundation any where, but in the Imagination only; and then in general terms, to tell us, how every thing in Nature may be produc'd according to that Hypotheſis, without being able to give a clear and ſatisfactory account of one ſingle Appearance. Nothing of this kind can be charg'd upon Sir *I. Newton*; he aſſumes nothing but Obſervations and Experiments, which are evident to the Senſe of all Mankind, and from thence he deduces demonſtrative Concluſions;

and

and then again, by the Assistance of these Conclusions, he Explains the Causes of many *Phænomena* in Nature. Thus it is evident, by undoubted Observations, that the *Planets* move in *Ellipses* round the *Sun*, and describe *Areas* always proportional to the Times; and that the *Satellites* do the same in respect of their primary *Planets*: From this he clearly demonstrates, that all the *Planets* have a *tendency* towards the *Sun*, and the *Satellites* towards the *Planets*, which they attend; that this *Tendency* decreases in a duplicate Proportion of their Distance; that moreover, there is an Universal Tendency of Matter to Matter; and that the Tendency of the Moon towards the Earth, is the very same with the force of Gravity, and is the cause of the Flux and Reflux of the Sea. This Tendency, or *Attraction*, some indeed may if they please term

term an *Occult Quality*, and I believe it will always remain ſo; for I cannot find, that the greateſt Philoſopher among the *Editors* will undertake to ſhew, how it may be produc'd Mechanically. But then, however *Occult* it be, as to its Cauſe, it cannot be call'd, what their Principles are own'd to be, an *Hypotheſis* or *Figment*; ſince the Exiſtence of it is as undeniably prov'd, as that of the Sun or the Planets. If then there be ſuch a Principle, which demonſtrably belongs to Matter, what Reaſon can there be, why we may not make uſe of it in Philoſophy? and ſhew how it is the real and adequate Cauſe of a great many Effects, which we daily obſerve.

So likewiſe, by the moſt Evident Experiments and Obſervations, Sir *Iſ. Newton* has found the different Refrangibility of the Rays of Light,

and by that means has discover'd such wonderful Properties of Light and Colours, that all the attempts, which have been made in this part of *Opticks* before, are trifling in comparison of his Performance.

The true way certainly of proceeding in these Philosophical Inquiries, is first to find out by many and undoubted Experiments, the Properties of Bodies; and then, without any farther Search into the Cause of such Properties, (which perhaps are insearchable) to explain the particular *Phænomena*, which depend upon them. By this Method *Archimedes* discover'd the Principles of *Mechanicks*, and the Laws of *Hydrostaticks*, without determining the Cause of Gravity and Fluidity. He assumes such Facts, as are evident to Observation and Sense, and from thence he demonstrates the Principles of those Sciences. So

likewise

likewiſe *Galilæo*, tho' he knew no Hypotheſis, which explain'd the Cauſe of Gravity, did notwithſtanding find out the Laws of *Acceleration* in heavy Bodies; the Motion of *Projectils*, and the Doctrine of *Pendulums*: And in a word, laid a Foundation for all the Diſcoveries, which have been made in Natural Knowledge ſince his time. Have not the Mathematicians made great Advancements in the Science of Opticks, by aſſuming two Principles of *Reflection* and *Refraction*, which are evident to Experience, tho' the real Cauſe of theſe two Principles is ſtill unknown to moſt of them?

According to the Principles of our Philoſophical *Editors*, all theſe great and noble Diſcoveries muſt be rejected, becauſe they are founded upon ſuch Properties of Bodies, as have unknown Cauſes; and *cannot*

be explain'd, without admitting Occult Qualities, which confound the Principles of true Philoſophy, and reduce it to its ancient Chaos. Wolfius, in his *Aerometria*, has aſſum'd for a Principle the Gravity of the Air, and from thence has deduc'd the Reaſon of many *Phænomena* in Nature; but he has no where given us a Mechanical Account of the Cauſe of this Gravity; and, I believe, never any Hypotheſis has been yet produc'd to explain it, but what *Wolfius* himſelf could eaſily demonſtrate to be falſe. Will the *Editors* object to him, that he has introduced an *Occult Quality* into Natural Philoſophy? Indeed Sir *Iſ. Newton* has gone farther towards Explaining the Cauſe of Gravity, which we feel and obſerve, than any one beſides; for he has ſhewn, that it ariſes from the Principle of *Attraction*, which all Matter has

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to Matter. Such a Principle of *Attraction* they are pleas'd to call a *Figment*; but how any thing ſhou'd be a *Figment*, which really exiſts, is paſt Comprehenſion. Sir *Iſaac Newton* has undeniably prov'd *one Species of Attraction* to be diffus'd through the whole Planetary Syſtems; and I have not heard, that any Objections, of the leaſt weight, have been rais'd againſt his Demonſtrations. I have more Experiments to prove the Exiſtence of this *other Kind of Attraction*, which decreaſes in a greater Proportion than the Squares of the Diſtance, and that it exerts itſelf vigorouſly in the minute Particles of Matter, than *Wolfius* has to prove the Gravity of the Air. Why then muſt we reckon the Principles, upon which the Reaſoning is founded, more a *Figment* in one caſe, than in the other? We find by Obſerva-

tion, that the Particles of Light, which flow from the Sun, the fixed Stars, or even our Terreſtrial Fires, are all equally attracted towards the Edges of Solid Bodies; and wherever there is Action, there muſt be Re-action: and therefore it may be concluded, that this Principle is really exiſtent, and equally diffus'd through all the Matter of the Univerſe. And tho' it may be inherent equally in all Matter, yet Mr. *Keil* has demonſtrated, that it muſt of neceſſity produce the moſt ſenſible Effects in the ſmalleſt Bodies.

But they ſay, *If we once allow ſuch a liberty of Feigning, others will invent other Occult Qualities, and ſo by degrees we ſhall return to the old Refuge for Ignorance: As if there be an Attractive Force or Sympathy, why not likewiſe an Antipathy, an Antiperiſtaſis and*

Qualities

Qualities emitted by way of Species: We may likewiſe allow of the Attractive Funicles of Linus, *and the Variation of Extenſion in the ſame Matter.*

If there be an Attractive Force? 'Tis clear and demonſtrable, that there is ſuch a Force. This is not an Hypotheſis invented to ſolve other *Phænomena*, but is it ſelf a *Phænomenon* in Nature: and therefore, tho' theſe *Editors* may think, they have urg'd the Defenders of it to an Abſurdity, yet the foregoing Argument, in which they ſeem to place ſo much Confidence, has really no more in it than this. If We allow of one Principle, which, by undoubted Experience, we are ſure exiſts in Nature; therefore we ought, upon the ſame account, to admit of others, which do not exiſt: for Inſtance, if we allow of Gravity, which by Ex-

perience we find to be in all Bodies, tho' we know not the Reaſon of it, therefore we muſt acquieſce in all the Fictions and Fancies of Philoſophers, of which we have no Experience, and for which no Reaſon can be aſſign'd. If this be a Mathematical way of Reaſoning, I muſt confeſs we had better *return to any old Refuge of Ignorance*, than allow of ſuch a liberty of Arguing.

But the great Objection againſt the Principle of *Attraction*, is, that there can be no Mechanical Reaſon given for it. Muſt we then allow of nothing, but what we can give a Reaſon for? Have ever any of them yet given a true and mechanical Account of the Elaſticity of the Air? which however is acknowledg'd by all Philoſophers, and ſeveral *Phænomena* are own'd to be rationally ſolv'd by it. We don't deny but a Clock-maker

may

may underſtand the Mechaniſm of a Clock or Watch, tho' he knows nothing of the Nature of Gravity or Elaſticity, which are the Principles that ſet all the Wheels in Motion: And for the ſame Reaſon, why may not he be allow'd to know the Mechanical Operations of Nature, who has diſcover'd the Spring, which actuates all the Bodies in the Univerſe, and preſerves them in their Order and Motions, and can give an account, how it mechanically produces each particular *Phænomena*; tho' at the ſame time he is intirely ignorant, as to the Cauſe of that firſt Spring, upon which they all depend? However if the *Editors* have a mind to attempt Explaining this Principle of *Attraction* mechanically, they have their full Liberty: Sir *Iſ. Newton*, I dare ſay, will willingly reſign to them the Glory of the Diſcovery;

and

and be ſatisfy'd, if he eſcapes their Cenſure, for not undertaking the Solution of ſuch an intricate Problem.

I know Mr. *L*——, whom the *Editors* conſtantly offer Incenſe to, in his *Specimen*, which he calls by an *Elegantly Sounding Word*, DYNAMICUM, poſitively affirms, that *an Active Principle conſtitutes the very Eſſence of a Material Subſtance* *.

* *Apr.* 95. Spec. Dynamicum, *In rebus Corporeis eſſe aliquid præter Extentionem, imo Extentione prius alibi admonuimus, nempe ipſam vim Naturæ ubiq; ab Authore inditam, quæ non in ſimplici facultate conſiſtit, qua Scholæ contentæ fuiſſe videntur, ſed præterea conatu ſive niſu inſtruitur, effectum plenum habituro, niſi contrario conatu impediatur. Hic niſus paſſim ſenſibus occurrit, & meo judicio ubiq; in Materia, ratione intelligitur, etiam ubi ſenſui non patet. Quod ſi jam Deo per Miraculum tranſſribi non debet, certe oportet ut vis illa in ipſis Corporibus ab ipſo producatur, imo ut intimam Corporum naturam conſtituat, quando agere eſt Character Subſtantiarum, Extenſioq; nil aliud, quam jam præ ſuppoſita nitentis renitentiſq; vel Reſiſtentis ſubſtantiæ Continuationem ſive diffuſionem dicit, tantum abeſt ut ipſammet ſubſtantiam facere poſſit.*

This

This Active Principle of Mr. *L*——'s, if I can rightly underſtand his Meaning, as he explains it, ſeems to be the ſame with the Tendency of Matter to Matter, which Sir *I. Newton* had long before diſcover'd, though he has no where affirm'd, that it was Eſſential to Matter. If Mr. *L*——'s Opinion be right, we may as well ſeek for the Mechanical Cauſe of the Extenſion and Solidity of Matter, as inquire after a Mechanical Account of an Attractive Principle, which is inſeparable from it. Upon this Suppoſition, all the Effects we obſerve daily in the Material World, do neceſſarily ariſe from the Eſſence of Matter. But I muſt own, I am not ſo well acquainted with the Eſſence of Matter, as to affirm, that ſuch a Power belongs to it Eſſentially, and is as neceſſary to it as Extenſion and Solidity. To

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me this Opinion labours under Difficulties, which are too many to be enumerated, and too great to be remov'd. However, if the Compilers of theſe Tranſactions be of Mr. *L*——'s Opinion, or any way favourable to it, I can't ſee why they ſhould be againſt admitting a Principle, which he finds to be ſo neceſſary, as to lay it down for a Maxim, that *it flows from the very Eſſence of Matter.* But ſince the Motions of all the Bodies in the Univerſe do plainly evince the Exiſtence of ſuch a Principle, if they are of Opinion, that it is neither Eſſential to Matter, nor to be mechanically accounted for, I cannot think it will be either *Abſurd* or *Unphiloſophical* to aſſert, that it *depends only on the Will of the Omnipotent Creator:* And that it is an univerſal Law, by which God Directs and Governs the *Univerſe*, and

makes

makes all the Parts of the material World move with exact Harmony and Order; tho' this very Principle, as well as the Frame and Conſtitution of Nature it ſelf, owes its Being merely to his arbitrary Will and Pleaſure. Whereas they who acknowledge no ſuch Principle, but will have all the Operations of Nature to be *Mechanical*, not only as to their Immediate but Remoteſt Cauſes, ſo that every thing in their Opinion reſults from the Eſſence of Matter and the unalterable Laws of Motion, ſeem to take away the neceſſity of owning a Supreme Infinite Intelligent Being, who Directs and Rules the Univerſe; and by that means they furniſh the Atheiſts with Arguments to defend and ſupport their Impious Cauſe.

However, whether they admit this *Attractive* Power of *Matter* or no, yet 'tis certain, there muſt be

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an active Principle ſomewhere or other exiſting in Nature; for Bodies once put into Motion, and then left to themſelves, will not produce ſuch regular and conſtant Appearances, as we daily obſerve. The Sagacious Mr. *L*—— ſaw this to be ſo neceſſary, that he made the very *Eſſence of Matter* to conſiſt in *Action*. Now, where ever this active Principle is, it muſt at laſt be reſolv'd into an *Occult Quality*; for as yet we are not able to find out any other cauſe for it, than the Will of an Omnipotent Being. Thoſe indeed who pretend moſt to Mechaniſm, place this active Principle in the *Æther*, or ſome extremely ſubtil Fluid; but then I wou'd ask the Queſtion, What is it, that actuates this *Æther*, and conſtantly preſerves it in Motion? How comes it to paſs, that contrary Motions do not deſtroy one another? And what

what is it, that determines theſe Motions, to produce ſuch particular Effects, and no others? Theſe muſt neceſſarily be *Occult Qualities* reſiding in the *Æther*. And indeed if we examine their Hypotheſis, we ſhall find, that they introduce many more *Occult Qualities*, than there are *Phænomena* to explain. Whereas Sir *Iſaac Newton* aſſumes but one Simple evident Principle

— *& Specioſa dehinc Miracula promit,*

for a proof of the Obſcurity and Weakneſs of their own Hypotheſis, I need go no farther, than by repeating, what the *Editors* themſelves deliver upon this Subject. They ſay, That *the particular Phænomena may be eaſily accounted for, and are already explain'd by Learned Men, without that Attractive Quality, which confounds the true Principles of Philoſophy.* For which purpoſe

purpoſe, they imagine *many Particles of Matter ſurrounded with a certain Magnetical Sphere of a Subtil Fluid, by whoſe Motion, as we ſee in our Magnets, they may either attract, or repel, or diſpoſe one another to a convenient Situation, as ſoon as they can gain their Liberty.* What is a certain *Magnetick Sphere*, but ſomething very *Occult*, which has a Quality ſtill more *Occult*, call'd *Magnetiſm?* How comes this Sphere of Subtil Matter always to accompany the Body, which it ſurrounds? One wou'd think, when the Body is mov'd, it ſhou'd leave its Atmoſphere behind it; for if we ſhou'd ſuppoſe the Earth to receive a new impreſſion of Motion, in any Direction whatever, it wou'd, according to the receiv'd Laws of Mechaniſm, leave not only its Atmoſphere, but every thing elſe, that lies looſe upon it, behind. Therefore

Therefore we muſt ſay in this caſe, that, either by ſome *Occult Quality*, this Atmoſphere muſt attend wherever the Body is mov'd; or elſe, by another *Occult Quality*, there is a new Atmoſphere of Subtil Matter produc'd. Then I wou'd know, what Quality it is, which puts this *Magnetical Sphere* in Motion, and what ſort of Motion it is, and how it is produc'd, which makes the Body *attract, repel, and diſpoſe other Bodies to a convenient Situation.* How many Occult Qualities muſt we admit of for every particular *Phænomenon*, inſtead of one, which extends itſelf through the Univerſal Frame of Nature. I cannot but obſerve, that theſe *Editors*, who are ſo very Vehement in Exploding an *Attractive Force*, and maintain, that all Appearances may be very well explain'd without it, are forc'd however to give it a

place in the very Explication, which they pretend to give of Things, without admitting it; and condescend to make use of this very Word, which they think *sounds so Elegantly*, to *palliate their Ignorance*. For they tell us of a *Fluid Sphere*, which *attracts*, *repels*, *and disposes to a convenient Situation*. Since there is so little Foundation for this Hypothesis, 'tis pity it shou'd have no more Consistence. 'Tis an easy matter, at this rate, to solve all the *Phænomena* of Nature; for a Subtil Fluid and a Magnetical Sphere may do Wonders, and serve to explain even Contradictions. And this extremely fine Matter and Magnetism, without any clear Account of their manner of Acting, seems to be as great a *Refuge for Ignorance*, as any *Occult Quality* that ever was yet admitted into Philosophy. After all, are not such

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Suppoſitions precarious? are they not properly Fictions, ſince neither the Exiſtence nor Properties of ſuch a Fluid can be diſcover'd by Obſervation, or prov'd by Reaſon? Let the Reader now judge, whether all their Objections are not much ſtronger againſt their own *Unhappy Method* of Philoſophy, than the true one. Their Aſſumptions are all Fictitious, having no Foundation in Experiments and Obſervations; and after they are allow'd, they are attended with ſo many dark and obſcure Qualities, that *Simpathy*, *Antipathy*, and *Antiperiſtaſis*, are altogether as Intelligible as they are. And indeed I never ſaw any Hypotheſis of this Sort, but what had ſomething in it more intricate and difficult, than the Thing they deſign'd to explain by it. In the Hypotheſis of the *Vortices* which is their Darling Syſtem, they

have never yet told us, why the Fluid Matter moves in Curve Lines, and turns round a Centre, when 'tis the Natural endeavour of all Bodies to move in a Right Line: How ſo many *Vortices* can avoid confounding one another's Motions: How it is, that the *Comets* paſs thorough them, and move in Directions contrary to the Motion of the *Vortex*; and are ſo far from being diſturb'd in the leaſt by its violent Rotation, that they obſerve the very ſame Rules, which the Planets do, in turning round the Sun, and gravitate towards it in the ſame manner. Theſe and innumerable other difficulties ariſe from the Hypotheſis of the *Vortices*; which, notwithſtanding, is made the Foundation of all this ſort of Mechanical Philoſophy. When they are to explain any particular *Phænomenon*, they introduce a very

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ſubtil Fluid, which has ſome odd Quality or Motion, by which the Thing is perform'd; and may not any one as eaſily ſay this, as affirm, that it is done by *Sympathy*, *Antipathy*, or any *Occult Quality?* And is not the one as much a Refuge for Ignorance as the other? And if we once indulge our ſelves in the Liberty of ſuch Fictions, why may we not admit of all others, which can be thought of, or imagin'd?

How different is the true way of Reaſoning from this! In it nothing is aſſum'd, but what can be prov'd by evident Experiment and Obſervation to exiſt in Nature: Tho' the Cauſe and Original of what is thus aſſum'd may be unknown, yet upon that may depend a great many Effects, which are conſtantly obſerv'd in the World; and therefore it is the buſineſs of a true

true Philoſopher, firſt to diſcover by Experiments the Properties of Bodies; and then, when they are once certainly eſtabliſh'd, to ſhew clearly and diſtinctly, what Effects naturally flow from them. 'Tis hard to conceive, there can be any Objection of conſequence, againſt this way of proceeding in our Philoſophical Inquiries. If the Principles or Aſſumptions be founded upon Experiments and Obſervations; if the Premiſes be allow'd, and there be no Inferences made againſt the Rules of Logick, the Concluſion muſt be certain: And whatever Appearances are explain'd this way, muſt be allow'd Advancements in the Diſcovery of Natural Knowledge. And ſo I preſume the Principle of *Attraction*, for any thing which the *Editors* have to object to it, remains ſtill in its full Force, and ſtands Immoveable.

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There is another *Poſtulatum*, which they are likewiſe pleas'd not to allow of, *viz. That the Moments of Bodies, or the Quantities of Motion, are in a Compound Proportion of the Quantity of Matter, and their Velocity*; *an Erroneous way of Calculating*, they ſay, *which has often been remark'd in their Tranſactions.* 'Tis true, there are two or three Papers * of Mr. *L*——'s upon this Subject; but as they are fill'd more with a Conteſt about Words, than any Mathematical Reaſoning, ſo what he has advanc'd is againſt the Senſe of all the Mathematicians in the World; many of whom have expreſly demonſtrated the Truth of this beyond Contradiction. To them therefore I refer the Reader for further Satisfaction, if he deſires it, in this Point: The Controverſy being too long and too foreign to the purpoſe, to be renew'd or inſerted here.

* *Anno* 1686 & 1691.

'Tis

'Tis time now to take my leave of the *Editors*, which however I can't do, 'till I have firſt return'd them my Thanks for tacitly owning, that the Principles made uſe of in theſe Lectures, ſuppoſing them to be true, are not at all ſtrain'd or perverted in the Application.

F I N I S.